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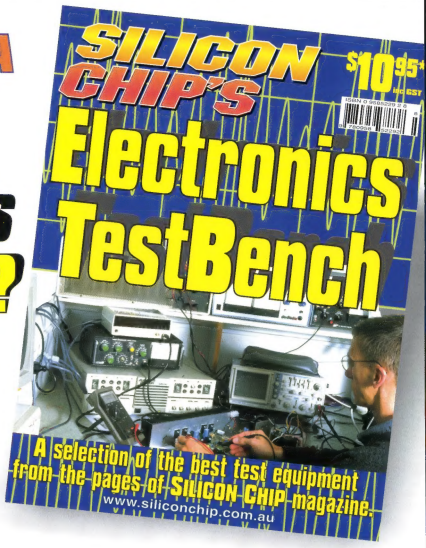

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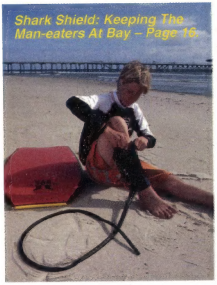

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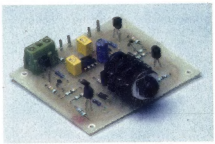

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PUBLISHER'S LETTER

A new reactor at Lucas Heights – it's about time

Finally, construction of a new nuclear reactor is about to commence in Sydney. The $320 million project has been the subject of a great deal of community controversy, much of it ill-informed. It will replace a reactor which is now 44 years old, highlighting just how overdue the project is.

In fact, when I toured the Lucas Heights reactor in around 1985, I was struck by how old the facility seemed even then. Not only did the whole installation need a good paint and general sprucing up, but everything about it was obsolete. All the control gear, instrumentation, computers and so on, was just ancient. I don't imagine that much would have changed in the intervening 17 years or so – it would just have continued to decay (pun intended).

Now, at the very least, with the installation of a new reactor, all the concerned people should be "happier". Sure they might still be up in arms about the reactor being just near their back fences but surely a newer, safer reactor must be better than one which is very old. And besides, when Lucas Heights was first built, it was way out in the scrub, far away from any houses. Those people who have moved and built there since really should not be complaining too much.

In the meantime, a great number of research people from a whole range of scientific fields, have had to make do with a second-rate installation. While they would have done their best with what was available, they would have been held back in their efforts. Just think, in the whole of Australia, for all this time, we have only had the piddly little reactor at Lucas Heights. It's been a bad joke for a long time.

Australia really does need to spend a lot more money in a whole range of fields and this nuclear reactor project is only a drop in the bucket of what should be spent to make us as competitive as possible on the world stage.

Spent fuel rods do remain a problem, particularly with Greenpeace doing everything in its power to stop them being sent to France, Argentina or where ever. At present, reprocessing of fuel rods is the best method of handling the problem, but Greenpeace won't have it. In fact, I find it extremely frustrating that the so-called "greens" or environmentalists seem to oppose just about every worthwhile project ever mooted in Australia.

Whether it is BassLink in Tasmania, wind farms just about anywhere, the tidal power project in Derby or any number of other projects that could have a significant benefit for the economy and the environment, the greenies are in there and against it. That their opposition appears to be supported by so many people is a sad reflection on the generally low level of scientific knowledge in the community.

Let's face it, if we had the same level of "green" opposition to major infrastructure projects 50 years ago that we have now, Australia would be a much poorer place with a woeful standard of living – in fact, we would be a "third world" country. Would the environment be better off? You only have to go and check the environment in a typical third world country to answer that question.

Leo Simpson

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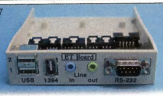

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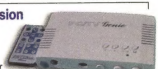

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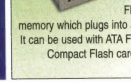

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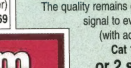

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Feedback on Dr Video's negative rail

I refer to the answer to R. L., on page 92 of the February 2002 issue, regarding the Dr Video negative supply. I also had the same problem and yes, the kitset had been supplied with a 7555 in lieu of a 555. However, replacing the 7555 with two different makers' 555 ICs did not fix the low negative supply rail. Perhaps the LED1 reference for Q4 has a higher forward voltage drop than in the prototype, causing the video output stage to put more load on the negative supply rail?

Anyway, in my case, I was using a 12V regulated plugpack and I found that replacing D1 (reverse voltage protection) with a 1N5819 which has a lower forward voltage drop made a marked improvement to the pre-regulation voltage. I had on hand a Jaycar "surplus" pack of 100V Fast Recovery diodes which had better than 100mV less forward voltage drop than the 1N4004s supplied for D2 and D3 and after fitting these I had about 7.5V into the 7905 -5V regulator. Perhaps 1N5819s in all three positions would be a cheap fix.

Like an earlier correspondent, I also had lower contrast at the output, compared with the input. Replacing D4 with a 1N4004 reduced the 5534's reference voltage by about 100mV and this rectified the problem.

As a matter of interest, I am using the Dr Video to remove the visible data pulses from the top of the picture, when watching ABC TV from a DGTEC STB in Wide Screen mode on a conventional TV (stops the Wide Screen music video clips from being chopped off at the sides). This was accomplished by switching carefully selected parallel capacitors across C9 and C10. Incidentally, temporarily paralleling a suitable value capacitor at this location will readily verify the action of IC5b in a clearly visible way.

On an entirely different subject, I have been using the rear end of your Dolby Pro Logic circuit (from the November & December 1995 issues) with two TDA1074a ICs, etc, in a preamp after an Onkyo Dolby Digital Decoder. Drastically reducing the value of the 180pF feedback capacitors from the inverting input to output of the inverting output buffers has noticeably improved the sound, bringing it closer to the sound of the DTS versions. However, both myself and a friend (who has recently purchased an upmarket multi-channel SACD player) have been investigating better options for multi channel preamplification. Perhaps your new 6-Channel IR Remote Volume Control will be the answer (or inspiration) to our search.

I hope you don't continue the practice of quickly rolling off the frequency response of your top audio creations. SACD and DVD-A deserve better than conventional top-end tailoring. Good quality modern equipment shouldn't output as much "digital rubbish" as earlier equipment.

I may have ageing and damaged hearing but even 48kHz 24-bit DVD sound compared to the CD version of the same music is obviously more natural sounding when fed through your Class-A modules via the same modules modified for preamplifier use, but with less intentional HF rolloff.

My friend has also found "good" commercial multi-channel gear sadly lacking on the SACD top quality setting. There is, however, no restriction on using the top setting when using his version of the "class A preamp" with an amplifier with some resemblance to your LD Amplifier (topology wise). I seem to remember reading several years ago, that even loudspeakers should go out to >50kHz to take full advantage of SACD and DVD-A.

Finally, I also am wondering what happened to the plan to locate Digital TV in the UHF band? I live in a mediocre TV reception area where aircraft pulsate the analog picture, there is a degree of multipath reception, and even a new upmarket antenna gives barely acceptable results much of the time. There must be hundreds of thousands of Sydney residents with even worse analog reception than me.

My experience of Digital TV reception is that the picture and sound are mostly superb, but the VHF channels are very susceptible to man-made interference, even when the signal level on the bargraph is in the good signal level area. The analog picture when the lady next door is mowing her lawn with a petrol mower is of course almost unwatchable but the Digital picture and sound is completely wiped out.

Even the fridge light turning on when the door is opened may cause a picture/sound disturbance. A fluorescent light that flickers or a neighbour

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using a food processor is another major cause of disturbances.

However, I may only get a fairly grainy picture on analog SBS in the UHF band and the STB bargraph says that the signal level is too low for reliable decoding yet most of the time I get perfect picture and sound, with a similar amount of disturbances to the VHF channels. Occasionally, in certain weather conditions, the signal level drops marginally and then the decoder has problems.

Why haven't we followed the UK example and put Digital TV in the UHF band which is obviously much more resistant to impulse type interference?

A. Kethel,
Waitara, NSW.

No-frills website is good

Congratulations on a useful website. It is useful because it does not have lots of useless irrelevant whirlygig graphics that consume bandwidth and CPU. It gets straight to the point of providing information, which is the only reason I use the net.

Within two mouse clicks I got directly to the information I was looking for. It did not have a convoluted path of links with their associated graphics, to get to the info I wanted.

Willem Corbett,
via email.

Shutdown for "no keyboard" computer

Here is a suggestion for a small addition to your very useful "No Keyboard" project in the February 2002 issue.

In not having a keyboard on a computer you can sometimes get stuck by not being able to reset or shut down the computer cleanly. By adding a switch which shorts the necessary lines into the keyboard controller to simulate a "Crtl-Alt-Del" key press, one will be able to reboot the computer. To find the lines to short, trace the tracks on the key matrix membrane or PC board.

"Crtl-Alt-Del" is especially useful for Linux since this performs a clean shutdown and reboot of the system. If other keys are needed (eg, F1), then these could be added as well. A useful addition would be one of the function keys assigned as a shortcut to cleanly shut down Windows.

Karl Gramp,
Athelstone, SA.

Check BIOS settings with IR port

What a pleasant surprise to see that nifty project for the PC IR Port transceiver in the December 2001 issue. I had been wondering about such a device and there it was. I couldn't wait for the kit so I made my own. In fact, I made two in case one 'died'.

Actually, one did die. It turned out to be because of the settings in the BIOS! The LED current limit of the IR transmitter is set to about 200mA which would quickly fry any LED unless the 'ON' time was only a quick burst.

But what if the LED stayed on? This can happen if the BIOS IR Port output logic is wrong. My Mobo (Gigabyte 7DXC) has the option where the IR input and output can be set to "inverting" or "non-inverting". Mine was set to *"TX,RX Inverting Enable . . Yes, No"*. This meant the output was inverted and the input non-inverted. So when I plugged in and powered up, the transmitting LED was turned full on, frying it!

Naturally, I wasn't aware of this until I smelt the "Dark Brown Smell" and saw the IR LED give a flash of light and a 'pop'!

I fitted the second IR transceiver with a 100Ω resistor to limit the current to about 20mA. Now I could investigate at leisure without the risk of cooking chips and that's when I finally understood what that 'Inverting Enable' meant in the BIOS. The working settings now are "TX,RX Inverting Enable.. No, Yes". Yeah, the RX was the wrong way too!

The port works a treat. My laptop can sit on the coffee table no further than a metre from my PC and still connect. I left the 100Ω resistor in place in case the BIOS settings are accidentally changed back.

David Vieritz,
via email.

Cure for LCD fault in Parallel Port PIC Programmer

I recently purchased and assembled the Parallel Port PIC Programmer project described in the March 2001 issue. It works well! I did encounter a problem when constructing the Liquid Crystal Display Adapter though and I thought I'd share my experiences so that other builders of this project need not tear their hair out to make it work. I purchased the display from Dick Smith Electronics (Cat Z-4170) and hooked it up using your recommended construction procedure. It did not work!

So, being new to "PICs" I embarked on the learning curve and dissected the code. It worked just fine in the simulator software available from MICROCHIP.COM (free) but the hardware refused to cooperate. Some (considerable) hardware debugging and many cups of black coffee finally stimulated the old grey cells to recall that CMOS-based peripherals often exhibit out-of-spec response times.

Focusing on the "LCDBUSY" subroutine in the program led to a detailed investigation of the LCD display response time to instruction "MOVF LCD_DATA,W" in this subroutine. Sure enough, the PIC did not read this correctly. It read some arbitrary data after executing this loop many(?) times. The trick I remembered was to re-read the peripheral several times if necessary. This fixed the problem and the program and hardware are working now.

To summarise, if you have problems getting the LCD display project

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to work, find and change:

MOVF LCD_DATA,W

to

MOVF LCD_DATA,W

MOVF LCD_DATA,W

in subroutine "LCDBUSY", then 'rebuild' the program and write it to the PIC using the Programmer.

Frank Winter VK4BLF,
via email.

A salve for greenhouse consciences

With regard to your article on solar power in the March 2002 issue, there is a cheaper and easier way to balance out the greenhouse gases that your car makes. Just pay $30 to the Green Fleet Sustainable Energy Authority. They claim that your $30 will be used to plant two trees that will convert the CO_2 gases generated by the average car. This is cheaper than changing your car.

Green Fleet have a web where you can go and find out where your trees have been planted. The URL is: **http://www.greenfleet.com.au/htm/who/who.htm**

Roderick Wall,
via email.

Electric wiring regulations

I have been a reader of SILICON CHIP for many years and I have noted several letters to the Editor from technicians (and possibly others) who are irritated by the restraints that they are placed under by electrical wiring regulations in Australia. I sympathise with them but it is very difficult to change such arrangements if such a move is seen by employee unions as having the potential to reduce employment opportunities.

My impression from this side of the Tasman is that the Australian union movement is a very strong one and is most unlikely to support the introduction or amending of new legislation that had the potential to reduce or eliminate employment opportunities for electrical workers.

The situation in New Zealand is covered by the 1992 Electricity Act which allows householders to carry out their own wiring but this wiring cannot be connected to a source of supply until it has been inspected and tested by a registered electrical inspector. Work of this nature carried out for hire or reward must be done by a registered electrician.

All wiring work done must (necessarily) comply with regulations made under the Act as well as any relevant Codes of Practice. There are also exemptions for the repair of domestic appliances by a householder where these are solely for use on domestic premises. The above are only two small extracts from an Act that covers 123 pages but it seems to work well and the electricians that I know are still earning a comfortable living.

As a registered engineer I am entitled to carry out so called "prescribed" electrical work but recently when I had a new electric stove installed I found it much more convenient to use the services of an electrical contractor. In this world, there is no substitute for experience and he was self-employed, fast and effective.

John C Rogers,
via email.

Inaccuracy in regard to tidal power

Ross Tester was inaccurate when talking of tidal power generation in the article on solar power in the March 2002 issue. The tide off north-western Australia often exceeds 10 metres 'P-P' but the peak spring tides are only a little more, I think around 13m. 'Tens of metres' is literally correct but misleading.

The plan for the Derby tidal power plant is to use hydraulic 'diodes' to pump up a 'capacitor' consisting of adjacent dammed inlets. One inlet would be 'positively' charged (thus tending toward 10m of stored water) and the other 'negatively' charged (tending toward 0m). The power generation equipment is sited between the two inlets and can work continually. Furthermore, peak generation can be matched to peak demand, not to peak tidal change. I think the newer dollar-saving cutdown plan for the plant is to have 50MW capacity, where the capability at the site is an order of magnitude more.

Ross should also have talked about batteries and the economic and environmental cost of maintaining them.

Another interesting issue with wind and photovoltaic generation is that there are benefits to having generation spread out as far as the grid reaches. Depending on the site, actual power generation is only 30% or so of peak generation, because of calm periods. Western Power is planning a wind farm in Geraldton, about 800km around the coast from Albany. Thus there will be some load-levelling because the weather at the two sites will not be the same.

Kevin Shackleton,
Cataby, WA.

(Editor's note: recent reports suggest there is some doubt about the financing of the Derby tidal power project).

Locating an article from ETI

I am trying to find an article published, if I remember correctly, in *Electronics Today* magazine, in the early 1970s. It was about the meaning of "watts" in relation to audio amplifier power output.

The general thrust was that they would use "Watts RMS" because most hifi magazines did, even though it was not correct. The article stated (correctly) that it should be "Watts Average" and did some math justification for that. Can you help me?

Doug Tipping, 140c Wonga Rd,
North Ringwood, Vic.

Comment: at this stage we are unable to help you since we do not have an index of the feature articles that appeared in ETI. However, we have published your letter in the hope that one of our readers can locate the article.

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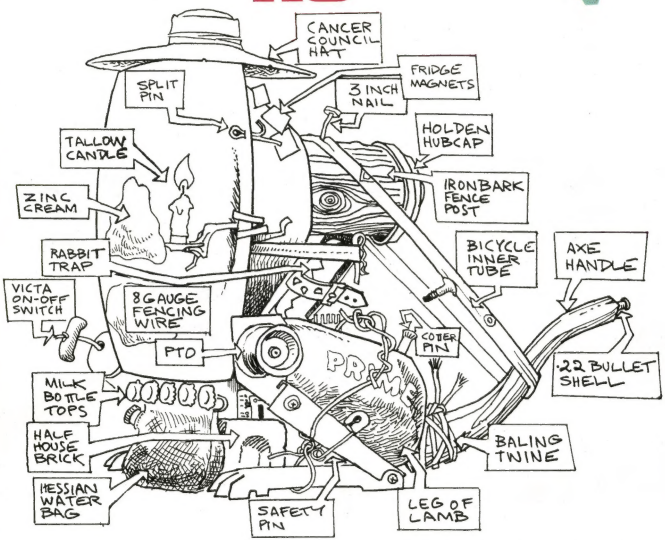

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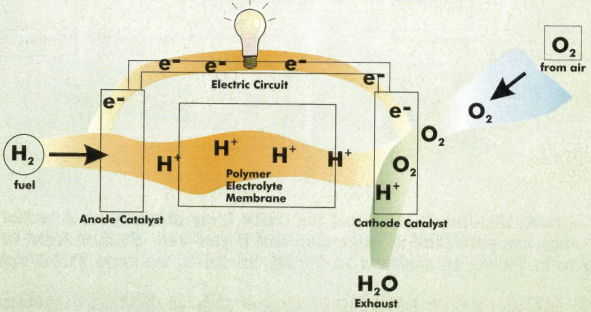
Fuel Cells:

the quiet power source that's soon to boom!



In this polymer electrolyte membrane fuel cell, hydrogen fuel is fed into the anode and oxygen (or air) enters through the cathode. Encouraged by a catalyst, the hydrogen atom splits into a proton and an electron, which, because of the chemistry, are forced to take different paths to the cathode. The proton passes through the electrolyte – which will vary in different types of cells – while the electrons create a current in an external circuit as they return to the cathode, where they rejoin with the hydrogen and oxygen to form a molecule of water. This current can be used in any way that an electric current from a generator or battery can be used, for example, to power a car. Using a fuel reformer, a fuel cell system can utilise the hydrogen from any hydrocarbon fuel—from natural gas to methanol, and even petrol. Since the fuel cell relies on a controlled chemical reaction and not relatively uncontrolled combustion, emissions from fuel cells are much lower than from even the cleanest fuel combustion processes

Fuel cells are not a new idea – for more than 200 years, researchers have been working on variations of fuel, electrodes and electrolytes to produce electricity. But with over 100,000 fuel cell powered vehicles expected on the roads by 2004, this quiet power source is at last becoming quite an achiever.

As early as 1802, at the age of 24, Sir Humphrey Davy (the mine safety-lamp man) created a simple fuel cell with which he was able to give himself a feeble electric shock. But he didn't bother to document it.

Then, in January 1839, Christian Friedrich Schönbein, the German/Swiss chemist who discovered ozone, published an article about the hydrogen-oxygen fuel cell in the *Philosophical Magazine* but he didn't pursue it either.

At about the same time, Sir William Grove, a Welshman who was working on the series and parallel connections of his powerful platinum-zinc battery, published an article, interestingly also in the *Philosophical Magazine* (perhaps I should be writing about the Philosophy of Fuel Cells).

Almost as an afterthought, Grove added a note to his article, based on experiments on the electrolysis of water he had carried out, of the possibility of using the hydrogen-oxygen reaction to generate electricity.

Early fuel cell noxious

Grove's first cell, known as the Grove Cell, used zinc in dilute sulphuric acid and platinum in concentrated nitric acid, separated by a porous pot.

Because it nearly doubled the voltage of the then-popular Daniell primary cell and could sustain strong current output, it became the favourite cell for the American telegraph for two decades in the mid 19th century.

However, when it was realised that the Grove Cell discharged poisonous nitric dioxide gas (picture large telegraph offices filled with rows of hissing Grove Cells!) the telegraph companies opted for the much less noxious Daniell cells.

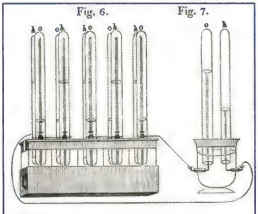
By the way, you might be interested to know that Western Union started life as the 'New York and Mississippi Valley Printing Telegraph Company', which yields the initials NYMVPTC, hardly a helpful mnemonic, later becoming the ubiquitous Western Union Telegraph Company.

by Gerry Nolan

Grove's second attempt, which he produced in 1839 and called a 'gas voltaic battery', was the prototype for today's fuel cells.

Having carried out experiments to split water into its component parts of hydrogen and oxygen by passing an electric current through it, as intimated in the postscript to his earlier *Philosophical Magazine* article, Grove tried reversing the reaction—combining hydrogen and oxygen to produce electricity and water.

This is the basis of the modern fuel cell and, because of his success in doing this, Grove is now known as the 'father of the fuel cell.'



William Grove's drawing of his experimental "Gas Battery" – image from *Proceedings of the Royal Society.*

Later on, the man who is said to have coined the term 'fuel cell', William White Jaques, substituted phosphoric acid (H_3PO_4) as the electrolyte bath. During the 1920s, further fuel cell research carried out in Germany laid the foundation for the development of carbonate cycle and solid oxide fuel cells.

In 1932, Francis T. Bacon (yes, apparently he was a direct descendant of the famous 16th century Francis Bacon) developed the first successful fuel cell, which he called the 'Bacon Cell'. He used hydrogen, oxygen, an alkaline electrolyte (potassium hydroxide—KOH) and nickel electrodes. The alkaline electrolyte performed as well as acid but was not as corrosive on the electrodes. Thirty years later, Bacon and a co-worker produced a 5kW fuel cell system.

Space program first practical application of fuel cells

The Bacon design was chosen by NASA, over nuclear power and solar energy, as the power supply for the Apollo and Gemini missions and the space station transport system (STS) shuttle orbiters – incidentally providing water as well as electricity. NASA went on to fund 200 research contracts for fuel cell technology. Both alkaline and polymer electrolyte membrane (PEM) fuel cells have been used successfully in the space program.

Serious interest in the fuel cell as an alternative generator of electricity for public use did not begin until the 1960s. Apart from the space program, until recently, major efforts with fuel cells were focused on developing stationary power units. This application was given a sharp boost in November 2001 when, as a result of the Californian energy crisis, the California State Government called for bids on stationary fuel cells. The preamble to the call document makes the case for fuel cells 'fairly' clear:

"California's recent energy experience [what a great PC euphemism for 'energy crisis'!] has confirmed that the state lacks reliable electricity generating capacity, and much of the existing capacity is over 30 years old. The California State Government, through the newly formed California Consumer Power and Financing Authority (the Authority), is pursuing expeditious means of increasing capacity, and increasing the role of renewable resources and cleaner, more efficient generation technologies. The siting of clean, efficient distributed power systems is an important element of this effort.

"State government is taking the lead in introducing stationary fuel cells as a preferred technology for distributed power, in part through the efforts of the California Stationary Fuel Cell Collaborative to foster fuel cell use in government buildings. Fuel cell capacity offered through the Authority will facilitate these efforts."

Fuel cells take to the streets

Claimed to be the earliest use of fuel cells in a public transport system, a pilot program, begun in December

White puffs of water vapour—the only emission product of fuel cells—emanating from the tail pipe attest to the truth of the banner (ZERO EMISSION FUEL CELL BUS) on this public bus, one of three in Chicago, Illinois. The hydrogen fuel tank occupies the entire roof area of the bus.

1997 by the Chicago Transit Authority, used buses powered by polymer electrolyte membrane fuel (PEM) cells provided by Ballard Power Systems, running on hydrogen gas. Liquid hydrogen, converted to gas for bus use, was supplied by Air Products & Chemicals. The successful conclusion of the trial was announced in March 2001.

Perth to trial fuel cell buses

From late this year, the Transperth public transport bus fleet will be augmented by three fuel cell buses for a trial period which will run for at least two years, part of a world-wide trial by DaimlerChrysler.

DaimlerChrysler is conducting an extended field trial involving 33 of its fuel cell powered Mercedes-Benz Citaro city buses, known as NEFLEET (new electric fleet). Equipped with the latest fuel cell technology, the buses will be tested in 11 cities for two years, commencing late in 2002.

Perth is the only city outside Europe to have been selected because, as Western Australian Minister for Transport, Murray Criddle, said, Western Australia was embarking on a long-term strategy to build a public transport system based on hydrogen fuel cell technology because it was recognised as having the best potential to combine zero emission with reliability.

The trial will enable the general public, fuel cell manufacturer, public transport authorities and hydrogen and filling station producers to gain everyday experience with the most new technology in a variety of climatic and topographical conditions.

DaimlerChrysler considers the fuel cell to have the potential to be the drive of the future and is investing around US$1 billion in its development over the next four years.

The hydrogen fuel cell

Fuel cell energy generated from hydrogen is the easiest to produce. It eliminates all carbon dioxide emissions and produces energy at greater efficiencies than petrol, diesel or methanol. A hydrogen-powered fuel cell is the only way to achieve a true zero emission vehicle with an extended driving range.

Basically, the hydrogen fuel cell works by bringing about a controlled reaction between hydrogen and oxygen. This reaction is simply electrolysis in reverse and the energy released is converted directly into electricity.

The hydrogen is able to pass through the fuel cell's electrolyte in the form of positively charged ions (protons). It then combines with the oxygen in the air to form water, leaving behind negatively charged electrons. As a nega-

DaimlerChrysler's NEFLEET (New Electric Fleet) Citaro City Bus. These fuel-cell powered buses will be trialled in 11 cities around the world this year, including Perth. The twelve-metre long low-floor solo bus will have a range of some 200 kilometres and can accommodate more than 60 passengers, depending on the individual customer specification. The fuel cell unit with a power output of over 200 kilowatts and the compressed gas cylinders containing hydrogen compressed at 350 bar are located on the roof of the Citaro bus. Maximum speed is up to 80km/h. The electric motor, transmission, drive-shaft and mechanical rear axle are mounted in the rear section of the bus. Three doors without steps and the continuous low-floor area through to the rear ensure a smooth flow of passengers on and off the bus.

tive charge accumulates on one side of the electrolyte and a positive charge on the other, an electric voltage is generated for use in driving an electric motor. The whole system acts like a battery but delivers its electric power only when needed.

Hydrogen can be used in its pure form, or can be extracted from a hydrogen-rich fuel, such as methanol, ethanol, or natural gas. Fuel cells are also capable of using hydrogen derived from trees and plants (biomass), waste gases generated at landfills and water pollution control plants, and from sunlight, wind and geothermal energy sources. Scientists are even generating hydrogen using enzymes taken from bacteria.

Hydrogen can be manufactured from a variety of sources, including natural gas.

As part of the fuel cell bus trial in Perth, BP is to establish a hydrogen manufacturing plant in Western Australia at its Kwinana refinery and will also establish Australia's first hydrogen refueling facility at a suburban bus depot for the Perth's new buses.

BP will use the Perth and European trials to help develop an efficient, effective hydrogen supply network for the future.

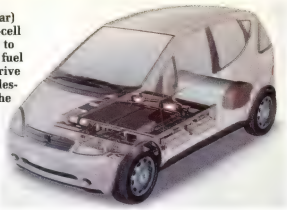
Other types of fuel cell

Basically, a fuel cell is any electric cell in which the chemical energy from the oxidation of a gas fuel is converted directly to electrical energy in a continuous process without combustion or pollution. The only byproducts are water and heat.

The efficiency of conversion from chemical to electrical energy in a fuel cell is between 65% and 80%, nearly twice that of the usual indirect method of conversion in which fuels are used to heat steam to turn a turbine connected to an electric generator.

The concept of using fuel cells was revitalised with the progress of energy technology for submarines, the Gemini space programs and the Apollo moon landings.

Among the advantages of the fuel cell are: its high degree of efficiency, a complete lack of any pollutant emissions, low noise levels, no moving parts and its modular design. This latter feature enables the output to be adjusted to the specific requirements of individual applications.



The Necar4 (New Electric Car) is a hydrogen-powered fuel-cell car that has been developed to demonstrate the viability of fuel cell cars as an alternative drive solution. Based on a Mercedes-Benz A-class compact car, the Necar4 has a top speed of over 140km/h and can travel nearly 450km without refuelling.

There are presently five major fuel cell types: alkaline fuel cell (AFC), molten carbonate fuel cell (MCFC), phosphoric acid fuel cell (PAFC), polymer electrolyte membrane fuel cell (PEMFC), and solid oxide fuel cell (SOFC). Each of these types will be described in more detail in a future article.

Fuel cells for your personal transport

Back in March 1991, I wrote an article in this magazine about electric vehicles and gave five reasons for choosing an electric vehicle (EV) over an internal combustion engined (ICE) vehicle as ". . . a shopping list for improving the environment". Of course, fuel cell vehicles are EVs and these reasons apply. The reasons:

(1) reduction of noxious emissions, especially in urban environments;
(2) more efficient use of available energy;
(3) reduction of audible noise in urban areas;
(4) reduced consumption of petroleum;
(5) greater flexibility of vehicle design and reduced vehicle maintenance costs and times.

DaimlerChrysler considers the fuel cell to have the potential to be the energy source for cars of the future and is investing around US$1 billion in its development over the next four years, when it expects to have 100 000 fuel cell powered cars on the road.

Practically every major vehicle manufacturer has at least one prototype fuel cell powered vehicle in operation. More comprehensive details about the different options being developed and how the different types of fuel cells operate will be given in future articles.

Briefly, fuel cells are more efficient than the internal combustion engine, running at greater than 60% thermal efficiency compared with the less than 25% typically achieved using a mid-sized car engine. PEM fuel cells also run cooler and produce far fewer emissions than internal combustion engines. Cars powered by fuel cell engines will be capable of travelling from 400km to over 600km before refueling and may be able to achieve 3-4 litres per 100km.

Virtually every major auto manufacturer in the world is developing fuel cell vehicles. The most optimistic is probably DaimlerChrysler. Fleet testing will begin this year under the California Fuel Cell Partnership.

Fuel cell vehicles are not only a cleaner way to travel, but will create an entirely new market, generating revenue and creating employment. At the average price of a car today, 160,000 fuel cell vehicles represents a US$3.2 billion market. It is predicted that, with a 10% market penetration, more than 100,000 jobs would be created in the USA alone.

Progress in putting the quiet achiever on the road

As I indicated earlier, only brief details of who is doing what about putting fuel cell powered vehicles on the road will be given in this introductory article. Considerable more detail about what is happening world wide and in Australia will follow in further articles.

OVERLEAF: WHO'S DOING WHAT IN FUEL CELL VEHICLE DEVELOPMENT? The answers just might surprise you!

In the United States of America

Ballard Power Systems

Ballard is the world's leading supplier of PEM fuel cells for transport and has received orders from vehicle manufacturers around the world. Late last year, Ballard introduced the Mark 902, its most advanced fuel cell platform to date. Ballard, DaimlerChrysler and Ford Motor Company have signed an agreement in which Ballard will acquire the interests of DaimlerChrysler and Ford in XCELLSIS GmbH and Ecostar Electric Drive Systems, LLC. This transaction increases DaimlerChrysler and Ford's commitment to, and reliance on, Ballard as their exclusive fuel cell engine supplier.

Chrysler (DaimlerChrysler)

DaimlerChrysler has unveiled a fuel cell powered Town & Country minivan, the "Natrium", which uses Millennium Cell's Hydrogen on Demand system. The unique feature of the Natrium is that the hydrogen for the fuel cell is generated from sodium borohydride, which is derived from borax.

Chrysler has unveiled its second fuel cell concept vehicle based on the Jeep Commander, running on hydrogen reformed on-board from methanol. This vehicle is actually a fuel cell/battery hybrid concept, with a nickel-metal-hydride battery to provide supplemental energy during acceleration, and for cold starts. It also uses regenerative braking to help recharge the battery. This combination gives the Commander 2 close-to-zero emissions, while achieving double the fuel efficiency of a conventional SUV

Energy Partners

Energy Partners (EP) is one of four fuel cell 'engine' companies participating in the US Department of Energy funded program.

EP actually claims the first fuel cell passenger car, a demonstration sports car called the 'Green Car' and also developed a demonstration fuel cell, utility vehicle based on John Deere's 'Gator' vehicles. The company has conducted interesting work on low cost fuel cell components.

Ford Motor Corporation

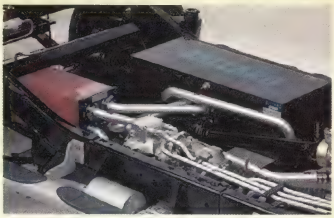
A group of Ford Motor Company personnel recently set a national endurance record with Ford's P2000 (SUV) fuel cell vehicle, which uses a methanol reformer. During the 24-hour test, they broke the US record for fuel cell endurance, maintained an average on-track speed of 104kph and an average overall speed of nearly 93kph. The vehicle travelled just over 2225 kilometres—further than any other fuel cell vehicle has travelled in a single day.

Ford has also unveiled the TH!NK FC5, a family size sedan powered by a Ballard fuel cell electric power-train using methanol fuel. Ford's P2000 Prodigy is a fuel cell powered sedan, running on stored hydrogen. It is designed to achieve the same performance as Ford's Taurus, with a fuel cell engine that achieves the equivalent of 67 kW.

Ford and Mobil are collaborating on a fuel processor to extract hydrogen from hydrocarbon fuels for use in fuel cell vehicles.

General Motors

In November last year, General Motors unveiled the fuel cell AUTOnomy, a platform that looks like a giant skateboard



in which the entire propulsion and electrical systems are built into a 152.5 mm-thick chassis. The chassis, long and flat, could be built in varying lengths and widths to accept a wide array of body types, from family sedan to SUV or from station wagon to hot little sports car.

General Motors and Suzuki Motors Corporation are collaborating to develop small-car applications for fuel cell technology. GM and ChevronTexaco Corp. have formed a pact to speed the introduction of petrol fuel cells in cars, a technology that is claimed to cut emissions of greenhouse gas carbon dioxide in half.

In 2000, General Motors unveiled its prototype HydroGen1 fuel cell, its smallest, most powerful fuel cell yet. The HydroGen1 is two-thirds smaller than previous GM models, yet provides 80kW of power, and has a thermal efficiency of 53 to 67 per cent. In addition, the HydroGen1 can start a car in temperatures as low as -40°C. General Motors also unveiled the Precept concept car in both hybrid and fuel cell powered forms. The Precept has a four-wheel drive, dual-axle setup. Electricity from the fuel cell is used to drive the electric motor on the Precept's front axle.

GM showed the Opel Zafira fuel cell minivan, powered by its seventh generation fuel cell system. The Zafira was the pace vehicle for the marathon at the 2000 Summer Olympics in Sydney.

GM's Delphi subsidiary is working with ARCO and Exxon to jointly develop on-board fuel processing technology and hardware to convert petrol to hydrogen for use in PEM fuel cell engines.

H-Power

H Power makes PEM fuel cells for a variety of specialty mobile applications. H Power supplied a PEM fuel cell to the Project New Jersey Venturer, a partnership between state government, private industry, and educational institutions to build and race a fuel cell powered car in the 1999 Tour de Sol Road Rally.

Humboldt University/ Schatz Energy Research Center (SERC)

SERC is researching and developing fuel cells for specialty vehicles and 'neighbourhood vehicles' which are now street-legal in the USA.

IdaTech

This company develops and commercializes fuel processors and fuel cell systems and tests synthetic diesel and synthetic petrol as on-board sources of reformed hydrogen

to power fuel cells.

Plug Power LLC along with Arthur D. Little Inc. and Los Alamos National Lab, has successfully demonstrated a fuel cell operating on hydrogen derived from petrol and is working on integrating the system into a vehicle.

Whistler Inc.

This company has successfully demonstrated the hydrogen-fueled Carbon-X fuel cell powered golf car, featuring a 48V proton exchange membrane fuel cell developed by Anuvu Incorporated.

United Technologies Corp.

UTC subsidiary, UTC Fuel Cells and Hyundai have worked together to produce four hydrogen-powered fuel cell vehicles based on the Santa Fe SUV.

These zero-emission vehicles have a 75kW fuel cell system and use a conventional car battery for start-up. Enova Systems will supply the electric drive train and power management systems for the vehicles. UTC is also working with Toshiba to develop a prototype fuel cell system that extracts hydrogen from petrol.

UTC, in partnership with the US DOE, has also developed a petrol-powered fuel cell system powerful enough to operate a car.

In Europe

BMW

BMW plans to unveil a hydrogen-powered Mini Cooper, featuring an internal combustion engine similar to its Clean Energy cars. The Mini Cooper features an advanced hydrogen fuel storage tank that utilizes the same space as a conventional fuel storage tank.

BMW and Delphi Automotive have unveiled their first development vehicle featuring a solid oxide fuel cell auxiliary power unit (APU). The APU provides sufficient energy for existing mechanically-driven sub-systems, such as the air conditioning and water pumps. The APU could also be used to run devices while the vehicle is idle.

BMW AG plans to fit an unspecified number of 7 Series sedans with fuel cells from UTCI Fuel Cells. The vehicle will run on a hydrogen combustion engine; the fuel cell will power the car's on-board electrical system.

BMW is also developing 2000 hydrogen fuelled FC forklift trucks for the company's own facilities prior to marketing them to other users.

DaimlerChrysler (formerly Daimler-Benz)

Daimler-Benz began road testing a fuel cell van, NECAR (New Electric Car), in 1993. Daimler has developed and operated four generations of fuel cell passenger vehicles, utilizing a variety of fuels. In November 2000, DaimlerChrysler presented the NECAR 5, the latest version, in Berlin. The NECAR 5 runs on methanol, unlike its predecessor, the NECAR 4, which ran on hydrogen.

Daimler also presented a fuel cell as a compact auxiliary power unit (APU) in an internal combustion Mercedes-Benz S class model.

Daimler is part owner of Ballard and partners with Ford in several ventures related to the development and sale of fuel cell vehicles.

De Nora S.p.A.

Having spun off its fuel cell R & D unit to form De Nora Fuel Cells, Italy's De Nora S.p.A works with PEM fuel cells for buses and marine applications. The company is cooperating with Renault and Peugot/Citroen on fuel cell car projects and De Nora supplied the fuel cell engine demonstrated in the Coval truck.

Fiat

In mid-2001, Fiat presented the prototype of its first fuel cell car, Seicento Elettra H2 Fuel Cell, a two-seater car which was developed with the support of the Italian Ministry of the Environment and runs on hydrogen.

Peugot/Citroen

PSA Citroen is working with Renault to speed the development of a commercially viable fuel cell car by 2010.

PSA Peugeot/Citroen is leading the HYDRO-GEN project, building a second generation PEMFC car powered by a De Nora stack and compressed hydrogen and Peugeot/Citroen is involved in a European joint PEM fuel cell program designed to reduce fuel cell system weight and costs.

Renault

Renault SA of France and Nissan Motor Co. have decided to develop cars with a fuel cell that runs on petrol and will market the fuel cell vehicles as early as 2005. Renault has also designed, built and tested a fuel cell powered Laguna Estate.

The FEVER ('Fuel cell Electric Vehicle for Efficiency and Range') is a Renault station wagon powered by a PEM fuel cell engine fueled by stored liquid hydrogen.

Volkswagen/Volvo

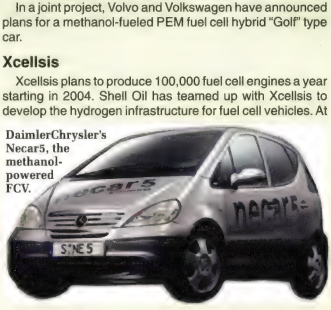
Volkswagen introduced its first fuel cell-powered car at the opening of the California Fuel Cell Partnership headquarters. The zero emission vehicle (ZEV) is called Bora HyMotion, is based on the Jetta and has a fuel cell engine which runs on hydrogen and has a power output of 75 kW.

Volkswagen is involved with CAPRI, a project that will deliver a prototype methanol FCV. Ballard will supply the fuel cell and Johnson Matthey a 'Hot Spot' reformer.

In a joint project, Volvo and Volkswagen have announced plans for a methanol-fueled PEM fuel cell hybrid "Golf" type car.

Xcellsis

Xcellsis plans to produce 100,000 fuel cell engines a year starting in 2004. Shell Oil has teamed up with Xcellsis to develop the hydrogen infrastructure for fuel cell vehicles. At



DaimlerChrysler's Necar5, the methanol-powered FCV.

the same time, the partnership is pursuing technologies to reform petrol.

ZeVco

In June 2001, London's Westminster City Council has bought a fuel cell van (pictured right), made by ZeVco, at a cost of 33,000 pounds (over $AU90,000).

The vehicle, which will be used in the upkeep of London's parks, has a top speed of just over 100kph and is 50% cheaper to run than a conventional combustion engine-powered vehicle.

ZeVco is the only company pursuing terrestrial development of alkaline fuel cells—that is, as opposed to development for space exploration.

Asia

Daewoo Motor

Daewoo intends to embark on a fuel cell research and development program with a state-run laboratory.

Diahatsu

Late last year, Diahatsu presented the MOVE FCV-K-II, a four-seater fuel cell mini-vehicle that uses a high-pressure hydrogen storage tank system. The MOVE FCV-K-II uses a 30kW Toyota fuel cell stack installed beneath the floor at the rear of the vehicle.

Honda

Late in 2000, Honda unveiled a four-seater fuel cell car, the FCX-V3, which has a motor 25% lighter than the two-seater fuel cell car it released the year before. The car also has a considerably faster start-up time – brought down to 10 seconds from 10 minutes! It uses a newly developed ultra-capacitor instead of a battery, resulting in improved acceleration.

Honda plans to build 300 fuel cell powered vehicles a year starting in 2003 for sale in Japan and the USA.

Hyundai

The Hyundai Santa Fe, powered by a 75kW PEM fuel cell, scored best in class in two key performance tests at the Michelin Challenge Bibendum, an annual event where new vehicle technologies are evaluated by independent judges. The Santa Fe scored an "A" in noise and a "B" in energy efficiency.

UTC Fuel Cells and Hyundai have worked together to produce four hydrogen-powered fuel cell vehicles based on the Santa Fe sport utility vehicle. These zero-emission vehicles have 75kW fuel cell systems and use a conventional car battery for start-up. Enova Systems will supply the electric drive train and power management systems.

Hyundai will also use fuel cells in its research and development of fuel cell technology as part of a cooperative program with the Korean government.

Hyundai has developed a fuel cell concept car powered by methanol with its affiliate Kia Motors Corp. The hybrid car, a result of a two-year project costing 9 billion won ($AU16,000,000), has a 10kW fuel cell.

Mazda

Mazda Motor Corp. plans to start test-runs of its 'Premacy FC-EV' car powered by a methanol-reformer fuel cell system and an electric motor in Japan and plans to start marketing fuel cell cars around 2005.

Mitsubishi

Mitsubishi plans to have a running prototype FCV with a production model ready in 2005. Nippon Mitsubishi oil is also working to produce a liquid fuel that can be used in fuel cells instead of petrol.

Nissan

Nissan Motor Co. and Renault SA of France have decided to develop cars with a fuel cell that runs on petrol and plan market the fuel cell vehicles as early as 2005.

Nissan showcased the new fuel cell-powered electric Xterra SUV at the opening of the California Fuel Cell Partnership headquarters. In May 2000, Nissan began test drives in Japan of a direct hydrogen fuel cell vehicle equipped with a methanol reformer. The Xterra utilizes this technology as well as a neodymium magnet synchronous traction motor combined with a lithium-ion battery.

Nissan and Suzuki have joined a government-sponsored project to develop direct methanol fuel cells for vehicles.

Suzuki

Suzuki unveiled a fuel cell-powered Covie two-seater at the 2001 Tokyo Motor Show. The vehicle features a General Motors fuel cell stack, and uses natural gas as the fuel.

Toyota

Toyota has demonstrated its new fuel cell hybrid vehicle, the FCHV-4, based on the new Highlander SUV. The vehicle, which Toyota says will be launched on a limited basis in 2003, will be demonstrated through their participation in the California Fuel Cell Partnership. Toyota says the vehicle, with a cruising range of more than 250km, has 'three times the vehicle efficiency of an ordinary gasoline-powered car.' Toyota also unveiled the FCHV-5, which runs on clean hydrocarbons, in Japan.

Toyota has also unveiled methanol and hydrogen fueled versions of its FCEV, based on the RAV4 sport utility vehicle. Both use Toyota's own PEM engines in hybrid configuration. Toyota plans to launch a commercial FCV in 2003.

Exxon and Toyota are working on technology to extract hydrogen from petrol, although Toyota has said methanol is the preferred option in the near term. **SC**

Acknowledgement: Much of the information in this feature appears by courtesy Fuel Cells 2000. Visit ***www.fuelcells.org*** for more information.

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G: STEREO AUDIO VIDEO TRANSMITTER / RECEIVER KIT.
This kit contains modules as per C & D and includes PBCs and all on-board components. .$119

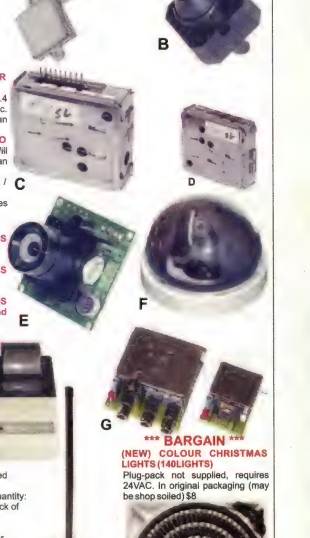
CAMERAS

B: MINI HIGH QUALITY LOW LIGHT CMOS PINHOLE CAMERA...
20 X 25 X 19mm. $98

E: MINI HIGH QUALITY LOW LIGHT CMOS BUTTON HOLE CAMERA WITH AUDIO
30 X 30 X 30mm. .$82

F: MINI HIGH QUALITY LOW LIGHT CMOS BUTTON HOLE CAMERA WITH AUDIO AND HOUSED IN A SECURITY DOME
Dia. 86mm X 60mm. $92

USED) LOW COST PRINTER: These serial interface printers are in good condition & were made in England. Supplied with ribbon installed. This is a rugged printer useful for Point of Sale applications. It is able to be used on a wide variety of hardware platforms - not confined to a PC. Any equipment with a standard RS232 port is capable of utilising this printer. (ZB0340) $50 each (limited quantity)



ROBOT BUILDERS BARGAIN!!!

RADIO CONTROL CAR / TRUCK REAR AXLE (DIFERENTIAL) ASSEMBLEY Complete assembly from a model car differential / gearbox and a 380 motor (Nom. 7.2V). The overall width is approx. 24cm. Good quality brand new unit as used in some Tandy electric cars. We have a good quantity in stock for a small fraction of their retail price - $11 for units with wheels.
Extra wheels $1ea

Type supplied may differ from the one shown.

635nM LEDS Bright (60mCd) 3mm red LEDS, type HLMP1340, data at fairchildsemi.com, large but limited quantity: 10 for $1.50, 50 for $6 or a sealed pack of 250 for $22

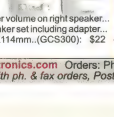
POWER TRANSISTORS 2N3055
New TO3 package metal cased power transistors, large but limited stock: $1.20Ea. or 10 for $8

REMOTE CONTROL TRANSMITTERS
Brand new Radio Shack two channel crystal controlled 27MHz transmitters with 2 3 position joystick, need 9V battery, style can differ from the pictured unit: $7 Ea. Or 2 for $10

***** BARGAIN *****
(NEW) COLOUR CHRISTMAS LIGHTS (140LIGHTS)
Plug-pack not supplied, requires 24VAC. In original packaging (may be shop soiled) $8

CAMBRIDGE SOUNDWORKS COMPUTER SPEAKERS

We have a limited quantity of these Cambridge SoundWorks GCS300 Computer Speakers. These are Brand New in original packaging that includes two speakers with power supply, cables, and manual.
Response: 90 - 20kHz...
Amplifier Gain: 12dB @ 1KHz volume max...
Output Power: 92 dB SPL at .5m listening position...
Power (each satellite): 2 Watt...
Input Impedance: 10K ohms...
Controls: On/off/master volume on right speaker...
Weight: 1.5Kg per speaker set including adapter...
Dimension: 153X101X114mm...(GCS300): $22 limited quantity.



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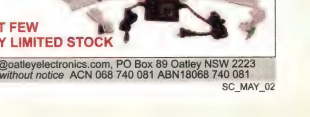

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SC_MAY_02

SHARK!

Sea Change Technology's Shark Shield: how one Australian company could make your visits to the beach a little safer . . .

by Ross Tester

The very mention of the word "shark" engenders dread in the vast majority of humans.

After all, we've all seen Jaws, Jaws 2, Jaws 3 (how many is it now?) and we know what those nasty creatures can do. And how clever they are.

And every year, just about the time you are starting to think that it's safe to go back in the water, one or more of our more sensationalist papers trots out some expert or other to warn that "this year will be one of the most dangerous on record for shark attacks . . . "

Yet most of our fear of sharks is completely without foundation.

As regular readers of SILICON CHIP may know, on my days off for good behaviour I am involved in Surf Lifesaving on Sydney's Northern Beaches. This includes training and examining new recruits.

One of the first and most-raised topics is about sharks. It's not just the kids – all ages are petrified!

When they see images on TV of the recent 2002 National Surf Lifesaving Championships at Kurrawa (on Queensland's Gold Coast) with literally dozens of sharks close inshore in a feeding frenzy, that fear is perhaps understandable.

To try to reassure them, I ask all new squad members to tell me when the last fatal shark attack occurred around Sydney. The answers usually vary anywhere from "last year" to "about 10 years ago."

The truth is that the last fatal attack occurred not off a surfing beach but in Middle Harbour almost 40 years ago (1963 to be precise), when actress Marcia Hathaway was mauled by a shark in less than two feet of water. (She died from shock/blood loss when the ambulance sent to retrieve her

burned its clutch out trying to get back up the steep track from the beach).

And as far as attacks off an ocean beach are concerned, we go back even further – much further. The last occurred in 1937 – incidentally the same year in which shark netting was introduced in Sydney. And there have never been any reported attacks between May and November.

In fact, you're much more likely to be killed by a wayward bee on your way to the beach than you are being taken by a shark. Worldwide, there are perhaps 50-75 shark attacks per year, with an average of 8-12 fatalities. Allergic reaction to bee stings takes many, many times this number each year!

There were 76 documented attacks in 2001, 5 of them fatal. This compares with 85 reported attacks in 2000, (12 of them fatal) and 58 attacks in 1999. Remember, this is world-wide!

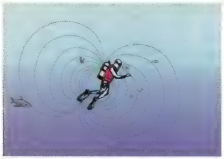
And compare that tiny number of fatalities with the 100-200 million sharks caught each year through fishing – they might be excused for wanting to get even!

Of course, there have been attacks – some of them fatal – in other areas of Australia. Two attacks in quick succession on Perth's Cottesloe Beach a couple of years back certainly got the tabloids into a feeding frenzy!

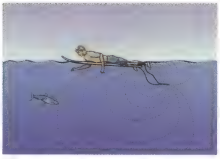
Shark netting

We mentioned shark netting a moment ago. This has been the preferred method of protecting humans for more than half a century. The idea of the nets (which are generally only 200m long and 6m deep) is not so much to "catch" sharks – though they do that – but to discourage sharks from establishing their "territory" near a beach.

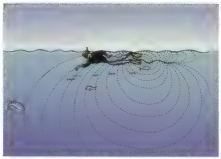
Fitting the Sea Change Technology "Shark Shield" before snorkelling or even catching waves – it's as simple as strapping the unit to your leg, and it could save your life . . .



The "figure 8" field produced around a diver, using the scuba tank as one of the electrodes.



A board rider has two trailing electrodes, resulting in a polar pattern under the surfboard.



The field for a swimmer or snorkeller with one trailing electrode is similar to that from the board rider.

The nets, with 50cm mesh, are not permanent – they are moved from beach to beach by contractors.

That they are successful is not questioned (no attacks off any Sydney beach since installation). However, in recent years conservationists have started to question the number of other marine creatures accidentally caught by the nets (dolphins, turtles, etc).

Fortunately for swimmers, governments have decided to keep the nets in place. Witness the history of Durban (South Africa) where a mesh barrier was put into place as far back as 1907.

It was in place for 21 years before it was allowed to fall apart. During those 21 years there was never an attack off Durban. Records for the years between 1943 and 1951 show that Durban had 21 shark attacks.

Not all sharks are dangerous

There are around 350 shark species, of which 32 have been proved to attack humans. Another 35 or so are considered potentially dangerous. The rest – such as the Port Jackson shark very commonly found in Sydney and southern Australia – might lick you to death (or perhaps scare you to death!).

There are three sharks which dominate reports of attacks: the great white, the tiger and the bull shark. All three can grow to very large sizes and all three are common in Australia. There are areas along Australia's southern coast where large numbers of Great Whites congregate; needless to say, swimming and surfing are not high on the sporting agenda. . .

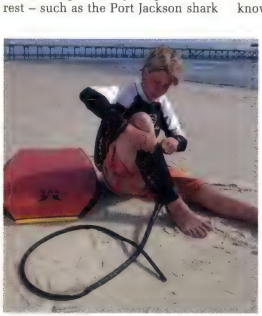
Having said that, the majority of attacks occur in the warmer waters of the tropics.

Why do sharks attack?

Many experts believe that attacks (particularly those NOT of the "big three") are often a case of mistaken identity – to a shark, a swimmer or surfer in a wet suit does not look all that different to a seal (yum!).

There have been many cases of sharks "tasting and spitting" which tends to reinforce that theory.

Some sharks, though, have been known to stalk victims. Others stage "hit and run" attacks where the victim has no idea of the shark's presence until the last moment.



It is believed that sharks sense their prey at least partially by electrical means. On the nose of all predatory sharks are small sensory organs called the "Ampullae of Lorenzini".

These organs can detect the tiniest of electrical currents (which are generated by all animals, humans included) and can guide a shark to its prey from some distance away, even to completely hidden prey. You might have seen film of sharks "digging" out stingrays which had buried themselves under a layer of sand to try to escape: the shark can detect their presence, via the Ampullae of Lorenzini, even under the sand.

Turning the tables

It is those same Ampullae of Lorenzini that researchers in South Africa discovered, several years ago, could be used to repel sharks.

By setting up an electric field around a swimmer/diver/surfer/etc, any predatory shark entering the field finds it impossible to stay. The same field does not affect humans or other marine creatures because they do not have the sensory organs.

The exact mechanism – why it works – is not yet completely understood. But it could be that the generated electric field is not only detected by the Ampullae of Lorenzini – it massively overloads this ultra-sensitive organ. The result is extreme discomfort and muscular spasms in the shark which cause it to veer away whenever it enters the field.

There is also evidence that the shark loses muscle control around the mouth and gill, meaning it may not be able to take a bite even if it wanted to. But no-one is quite willing to test that theory!

First developed in Natal, South Africa, for professional divers, Adelaide-based SeaChange Technology has refined and miniaturised the original "Shark Pod" into its recently released "Shark Shield.". Both use the same technology but the Shark Shield is very much smaller and lighter, a "personal" version.

SeaChange Technology's Technical Director, Mike Wescombe-Down, said that the Shark Shield was the result of many years of development, refinement and above all testing and retesting. And those tests have been 100% effective agains a variety of sharks.

He was not at all reticent about shar-

ing some of the technical features of the Shark Shield with SILICON CHIP. However, we must warn readers not to think this information is an invitation to try to build your own version.

As we mentioned before, sharks can sense the tiniest electrical stimulii – and during their early testing, the Natal Board of Sharks even found that a very slight variation in the waveform actually attracted sharks!

We'd hate to think that readers would try to build their own version, because if it doesn't work as intended, you won't get a second chance to fix it!

"You can't argue with a Great White bearing down on you at speed," said Mike.

How does it work?

The heart of the Shark Shield is an intelligent microprocessor-controlled high-voltage pulse generator.

The patented, very complex waveform includes a very fast-rising pulse every 500ms.

This is fed into the trailing electrodes or "antennas" which in turn produce the electric field in the water.

The microprocessor not only controls the waveform generation but also detects whether the antennas are under water (it throttles back the output if they are not) or whether they have become short circuited. If so, it switches over to a test mode and restores the output when the short is removed.

The pulsing field (which can be felt on bare skin in salt water but does not cause discomfort at reasonable distance) decays quite dramatically from the antennas but is effective up to a range of about 2-3 metres and even up to five metres.

Several factors affect the output and hence distance:

Water temperature (the warmer the water the more output) – fortunate, because shark attacks do increase with warmer water!

Battery life – also affected by temperature.

Water salinity – requires salt water (does not work in fresh, is very limited in brackish).

Size of electrodes (antennas) and spacing – the Shark Shield antenna is designed to be have the most effect possible without compromising the user's mobility. The dive model has larger electrodes, more widely spaced, and has a range of three to five metres or so.

There are two models of Shark Shield: the more powerful (4-5m range) DIVE01 unit is 21cm x 7cm x 3cm and weighs 590 grams (excluding electrodes and pouch). The combined total weight is about 1kg; and the GPSS01 (personal) unit is 17cm x 7cm x 3cm and weighs 450 grams (excluding antenna and pouch) The combined total weight is about 960 grams.

Testing the Shark Shield

As we said before, a huge amount of laboratory and field testing has taken place before the Shark Shield was released to the market.

Scientists know that sharks are much more intelligent than most people give them credit for (hence the success of shark netting). But that intelligence could just as easily have turned a "normal" shark into a dangerous predator.

Much of the testing involved the use of shark bait and bloodied water. SeaChange Technologies used a variety of test floats and scenarios to ensure that the sharks would not associate a particular float (such as a surfboard) with a food source, even if much of the time they were repelled.

The types of sharks tested included the "big three" mentioned above – great whites, bull sharks and tigers, but also included makos (known to become very aggressive and a threat to man) and, interestingly, the ocean white-tip shark. This particular shark is thought responsible for a huge number of attacks on sailors off sinking ships during World War II, attacking in packs and creating carnage.

Testing will never stop

Mike Wecombe-Down says that his company will continue to develop the Shark Shield and related products.

"We have an ongoing program of testing and refining, at the same time looking at ways of adapting the technology for other uses."

"We're already working on an electronic beach barrier, something that in time may replace beach netting. But the biggest problem to date has been not only getting sufficient energy to where it is required but making the package strong enough to withstand the forces of nature," he said.

Research and Development has commenced on variants of the Shark Shield, suitable for sailboarding, jet skiing, kayaking, boat protection and even a model for life jackets.

A commercial range is also planned, which will include protection for aquaculture stocks and electronic beach barriers.

SeaChange Technologies' Technical Director, Mike Wescombe-Down. Thanks to Mike for his assistance with this feature.

Where, how much?

Retail price of both units is about $700.00. The Australian and New Zealand distributors of the product are Aquanaut Pty Ltd (*www.aquanaut.com.au*); more information about the Shark Shield can be found on *www.seachangetechnology.com.au* **SC**

The Shark Shield is a development of the earlier POD, originally used by divers in South Africa.

DICK SMITH ELECTRONICS

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SHRINKBUSTER CHIP Apr '01

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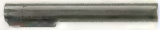

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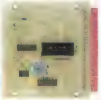

NEW velleman kit

Crawling Bug Mini Kit

An attractive, bright coloured bug-shaped miniature robot. It drives toward light and you can choose between two different walks. Adjustable light-sensitivity suits almost any conditions and allows you to control it's 'bug-like' behaviour. LED eyes indicate driving direction. Stops in total darkness. Requires 2 x 1.5V AAA batteries (not included).

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This is a compact 70W class-H audio amplifier module. Based on the Philips TDA1562Q IC, this compact audio amplifier module can deliver up to 70W into a 4 Ohm load when powered from a 12V car battery. The perfect audio amplifier module for use in a portable PA, a tiny sub-woofer amplifier, a busking amplifier, or a car audio amplifier. Kit supplied with PCB and all necessary components.

K 3401

$39.88

SHRINKBUSTER CHIP Mar '02

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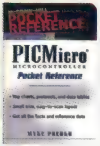

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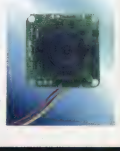
L 5874



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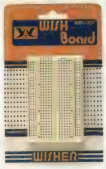

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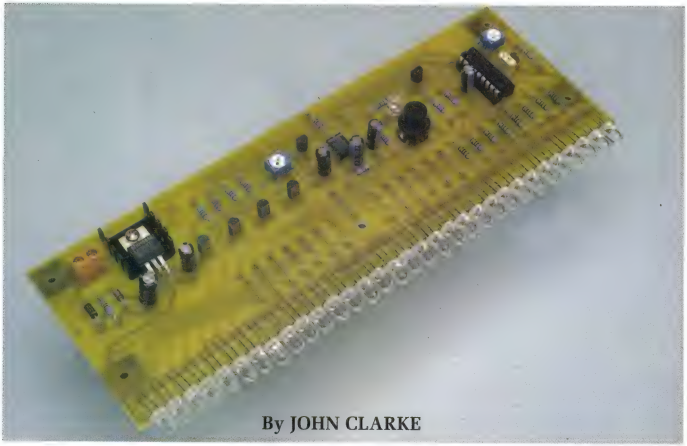
More LEDs, more patterns, more exciting than ever

32-led knightrider

Flashing LED displays are always intriguing, particularly if they emulate the KnightRider car from the old TV series. This KnightRider light chaser includes 12 different lighting patterns using 32 LEDs for a big and impressive display. Not restricted to KnightRider use, the display can be used as a rear window brake light or as an eye-catching conversation piece at parties or even on retail displays.



By JOHN CLARKE

In the early 1980s there was a TV series called KnightRider. Its "star" was a rather clever car going by the fetching name 'Kit'.

Mind you, Kit was no ordinary car. It had powers and abilities far beyond those of mortal cars. Kit could talk, drive itself and supposedly see using a row of lights on the front which 'scanned' from side to side to simulate monitoring what was ahead.

While the KnightRider TV series has long since ceased, such scanning lights have continued appeal and we have published two different KnightRider light displays, one in November 1988 and the other in May 1996. Both of these used 16 LEDs and had a single fixed scanning display pattern.

Features

* 32 LEDs
* 12 LED display patterns, including medleys
* Adjustable pattern speed
* Adjustable LED brightness
* 12V operation

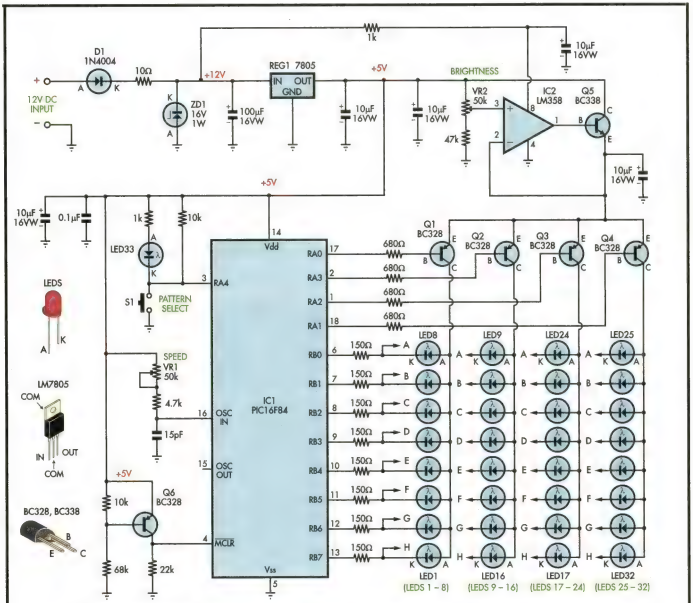
But both of these were in the days before microcontrollers – or at least before microcontrollers were commonly used in projects.

Our latest version of KnightRider has twice as many LEDs, 32, and a number of different display patterns are available which are selected using a pushbutton switch. There are four scanning sequences, a chaser and a strobe.

If you mounted the display on your car's parcel shelf, you could also use it as a brake light.

The patterns

The four scanning patterns include the traditional movement of LEDs from left to right and from right to left which is repeated to simulate scanning across a field in front of the LEDs. Pattern 2



SC 32-LED KNIGHT RIDER

Fig.1: in this circuit, the 32 LEDs are arranged in an array, driven in their various patterns by the PIC microcontroller.

begins with two LEDs in the centre LEDs which then spread (light up) to the left and right and contract back to the centre.

Patterns 3 and 4 are similar, with pattern 3 moving from the centre to the outside and then back to centre again. Pattern 4 starts from the outside LEDs and moves to the centre and then back the outside again.

Chaser sequences include a right to left movement and a left to right movement. The strobe patterns can be at a regular or random flashing rate.

For brake light use, there are two patterns. The first lights all LEDs initially for a minimum of about 18 seconds (depending on the speed setting) and then the LEDs randomly switch off until they are all out. Alternatively, you can just have all LEDs lit while ever the brake is applied.

The KnightRider PC board measures 210 x 72mm. All 32 LEDs mount horizontally along one edge of the PC board. There are two trimpots, one to adjust the LED scanning rate and the other to adjust display brightness. A pushbutton selects the display pattern while a LED next to the switch flashes once or more to indicate the pattern that has been selected.

Circuit description

Apart from the 33 LEDs, the KnightRider uses relatively few components and is based around IC1, a PIC16F84 microcontroller. This provides all the LED patterns.

The PIC16F84 has 18 pins, 13 of which can be used as inputs or outputs. For our circuit we are using 12 as outputs to drive the LEDs and one as an input and an output to monitor the pattern select switch and drive the pattern LED. Fig.1 shows the circuit details.

Multiplexed rows and columns

While the 32 LEDs are physically arrayed along one side of the PC board, they are actually connected as a matrix of four columns and eight rows, as shown in Fig.1. The eight rows are driven directly from IC1 (RB0-RB7) while the four columns are driven by four transistors, Q1-Q4. These transistors are switched by the RA0, RA1, RA2 and RA3 outputs of IC1.

When the RA0 output (pin 17) is pulled low by IC1, transistor Q1 is switched on and applies power to the anodes of LEDs 1-8. A low output on any of the RB outputs will drive the LED connected to it via its series 150Ω resistor. For example, if RB0 goes low, LED1 will light.

The RA0 line is kept low for a short time before this goes high to switch off Q1. Thus LEDs1-8 are switched off. The RA3 line (pin 2) is then brought low to drive Q2 and the anodes of LEDs 9-16. Now any low RB outputs will then light up LEDs 9-16. Similarly, RA2 (pin 1) is brought low to drive Q3 and LEDs 17 to 24 and then RA1 (pin 18) is pulled low to drive Q4 and LEDs 25-32.

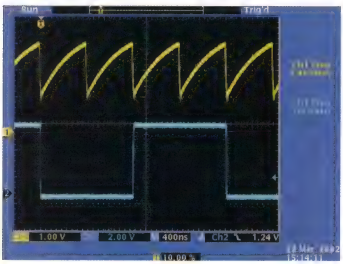
This cycle repeats endlessly with each column of eight LEDs being lit at a very fast rate so that the LEDs appear to be continuously lit rather than only being on for some of the time. This system of driving the LEDs is called "multiplexing". Its big advantage is that it saves power and drastically reduces the number of connections required. If the LEDs were not multiplexed we would need 33 separate lines (32 actives and one common) whereas with multiplexing we can drive the 32 LEDs using only 12 lines connected in the matrix.

Brightness control

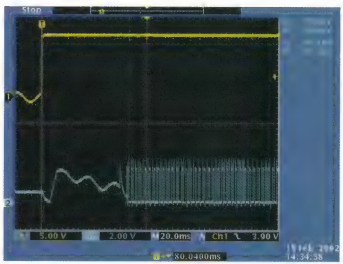
Overall LED brightness is controlled with trimpot VR2. This varies the voltage at pin 3 of IC2 from 5V down to about 2.4V when the wiper is at its lowest point. Op amp IC2 operates as a unity gain buffer amplifier, with transistor Q5 providing extra current drive capability.

If the emitter of Q5 is at 5V, the LEDs will be driven at maximum brightness. Typical LED current will be (5V - 1.8V)/150Ω, or 21mA. This is the pulse current, not average current.

The pattern select switch S1 connects to RA4 of IC1. This pin is normally held at 5V via the 10kΩ pullup resistor. When S1 is pressed, LED33 lights and RA4 is pulled low. This is recognised by IC1 as a switch closure and the next pattern in the sequence of 12 is selected. When the switch is



Scope 1: The upper trace is the oscillator waveform at pin 16 (OSC IN). This is a classic sawtooth expected from a relaxation oscillator. The lower trace is the waveform at pin 15 (OSC OUT) which in this RC mode is a square wave at one quarter the oscillation frequency.



Scope 2: These traces show the time duration between when power is applied to the circuit and when the LEDs light for the brake light pattern selections. Top waveform is the applied voltage and when this goes high, there is some 67ms before the LEDs light. This is fast enough to display almost instantly the brakes are applied.

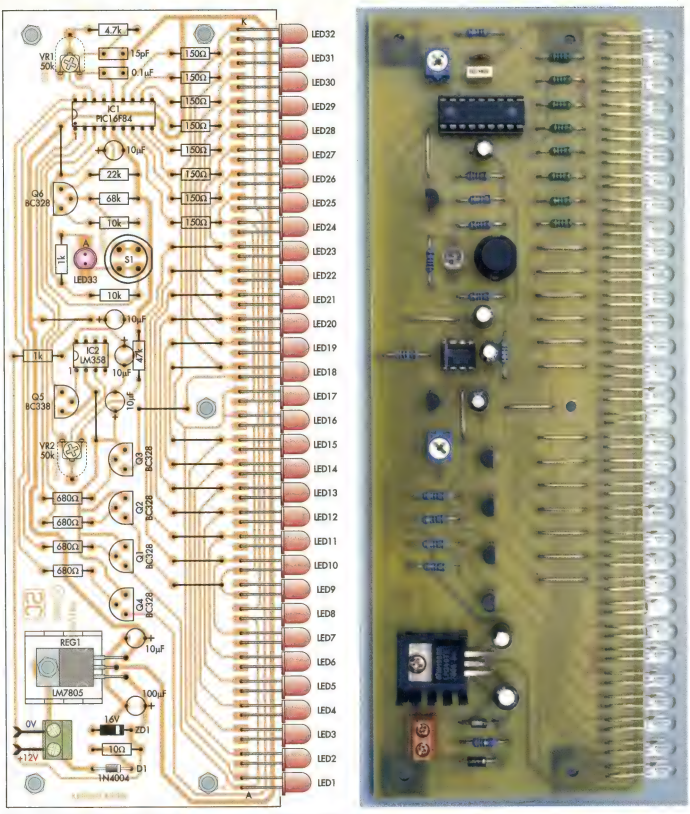


Fig. 2: here's the full-size PC board component overlay, with a matching photo to make assembly a breeze!

released, IC1 flashes LED33 to indicate the pattern selected. For example, pattern 2 is indicated by two flashes.

Note that the RA4 pin is an open drain output when configured as an output. This allows RA4 to drive LED33 when pin 3 is low. When RA4 is set high, the open drain connection means that it becomes a high impedance output which is pulled high via the 10kΩ resistor. In this condition, IC1 can monitor RA4; if it is pulled low, that indicates that the switch is closed.

No crystal required

Most PIC circuits use a crystal for

Parts List – KnightRider

1 PC board coded 08105021, 210 x 72mm
1 heatsink, 19 x 19 x 10mm
1 2-way PC-mount screw terminal
1 snap-action PC pushbutton switch (S1)
1 M3 x 6mm screw and nut
4 adhesive rubber feet
1 350mm length of 0.8mm tinned copper wire

Semiconductors

1 PIC16F84P (IC1) programmed with Knight.hex
1 LM358 dual op amp (IC2)
1 7805 regulator (REG1)
5 BC328 PNP transistors (Q1-Q4, Q6)
1 BC338 NPN transistor (Q5)
1 16V 1W zener diode (ZD1)
1 1N4002 diode (D1)
33 5mm red high-brightness LEDs (LED1-LED33)

Capacitors

1 100µF 16VW PC electrolytic
5 10µF 16VW PC electrolytic
1 0.1µF MKT polyester (code 100n or 104)
1 15pF NP0 ceramic (code 15p or 15)

Resistors (0.25W, 1%)

1 68kΩ — blue grey orange gold
1 47kΩ — yellow purple orange gold
1 22kΩ — red red orange gold
2 10kΩ — brown black orange gold
1 4.7kΩ — yellow purple red gold
2 1kΩ — brown black red gold
4 680Ω — blue grey brown gold
8 150Ω — brown green brown gold
1 10Ω — brown black black gold
2 50kΩ horizontal trimpots (code 503) (VR1,VR2)

the internal oscillator but this circuit does not require precision timing. For these situations, the PIC can be set up as a relaxation oscillator (similar to the 555) whereby a capacitor connected to pin 16 is charged from the positive supply (+5V) via a resistance and then discharged via an internal transistor.

In this case we connected a 15pF capacitor to pin 16, charged from +5V via trimpot VR1 and a 4.7kΩ resistor. The classic sawtooth waveform of the oscillator can be seen in the top trace of Scope 1.

Interestingly, the waveform at pin 15, OSC OUT, is not the same as at pin 16. Instead it is a square wave at one quarter the frequency.

Frequency of operation can be varied from about 4MHz when VR1 is set to minimum resistance, down to about 500kHz when VR1 is at maximum resistance.

Transistor Q6 and its associated resistors provide a reset for IC1 when the supply is below a certain voltage. This ensures correct start up for IC1 when power is applied.

The circuit can be powered from a 12V battery, DC power supply or DC plugpack. Diode D1 gives reverse polarity protection while the 10Ω resistor and zener diode ZD1 provide transient protection.

The 12V supply is filtered with a 100µF capacitor before being applied to REG1, a 5V regulator. Its output is decoupled with a 10µF capacitor to ensure stability.

Software

The software required to provide the various LED display patterns was written to minimise the number of instruction codes. This is because there are only 1024 bytes of memory and we would quickly run out of space if we were to list each individual LED and its state during a pattern sequence. This normal approach involves using a lookup table.

Instead of using a lookup table, the software makes note of the fact that much of the sequence is repetitive and only a short list of LED switching operations is required. This list is used in various ways to generate the required pattern.

The efficiency of this approach is evident by the fact that we managed to include some 12 distinct patterns into the software with some space left over. In contrast, if we had used a lookup table it would have only allowed one or maybe two patterns at the most.

The full software listing for the KnightRider is called knight.asm; it (and the .hex file) is available from our website – *www.siliconchip.com.au*

Construction

The KnightRider is constructed on a PC board coded 08105021 and measuring 210 x 72mm. Begin construction by checking the PC board for shorted tracks or any breaks in the copper pattern. Check the pattern against the published artwork to verify that it is correct. Repair any defects on the PC board before starting assembly.

Fig.2 shows the component overlay for the PC board.

First, install all the links on the PC board. Then install the resistors, using the colour codes shown in the parts list as a guide to selecting the values. You can also check each value with a digital multimeter to be sure that you have the correct resistor for each position. The diodes can be installed next, taking care not to confuse zener diode ZD1 with standard diode D1.

IC1 is mounted using a socket while IC2 can be soldered directly into the PC board. The 3-terminal regulator is mounted horizontally, so carefully bend the regulator leads before inserting them into the relevant holes on the PC board. It is mounted onto a small heatsink and secured with an M3 screw and nut.

When installing the five transistors, make sure that the BC338 is placed in the Q5 position.

Next, install the capacitors. The codes of low value types are listed in the parts list. The electrolytic capacitors will have their values marked in µF; be sure to orient them correctly.

Switch S1 should be installed with the 'flat' side oriented as shown Fig.2. Insert LED 33 with the anode (longer lead) placed toward the VR1 side of the PC board. Trimpots VR1 and VR2 and the PC-mount terminal block can then be soldered into place.

Finally, the 32 LEDs can be installed along the edge of the board. They are placed with the anode leads (longer lead) to the left.

You can preform all the LED leads by cutting a length of cardboard 10mm wide. Place the LED across this with the anode to the left and bend the leads downward. This will allow the LEDs to be inserted into the PC board with sufficient clearance for the LED body to just protrude over the front edge of the PC board.

Check your work carefully for correct orientation of the capacitors, for the correct transistors in each place and the correct orientation of IC2 and the socket for IC1. Do not install IC1 yet.

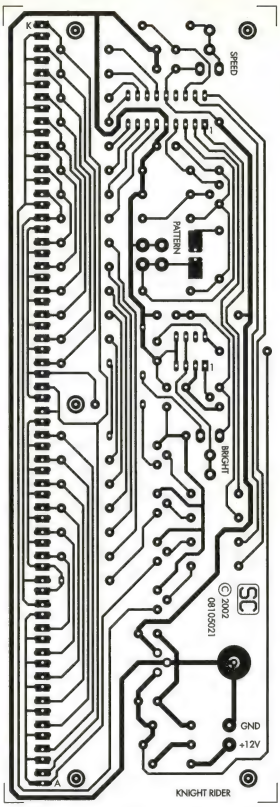
Testing

Now apply power to the +12V and

TABLE 1: PATTERNS AVAILABLE

No.	Type	Pattern Description	Repeat
1	Scan	LEDs move from left to right and then right to left	yes
2	Scan	LEDs move symmetrically from centre to outside and from outside to centre	yes
3	Scan	LEDs move symetrically from centre to outside	yes
4	Scan	LEDs move symetrically from outside to centre	yes
5	Scan	Patterns 1, 2, 3 & 4 selected in sequence with change every power up	yes#
6	Medley	8 cycles of pattern 1 16 cycles of pattern 2 16 cycles of pattern 3 16 cycles of pattern 4	yes ##
7	Chaser	LEDs chase from right to left	yes
8	Chaser	LEDs chase from left to right	yes
9	Strobe	All LEDs on then off at regular rate	yes
10	Strobe	All LEDs on then off at random rate	
11	Random	LEDs lit at random until all on, then off at random until all off	yes
12	Medley	100 cycles of pattern 7 100 cycles of pattern 8 20 cycles of pattern 9 20 cycles of pattern 10 2 cycles of pattern 11	yes+
13	Brake	All LEDs on at power-up for 18s minimum then off at random until all off	no
14	Brake	All LEDs on at power up and remain on until power off	no++

\# (of selected pattern)
(Medley repeats of patterns 1, 2, 3 & 4)
\+ (Medley repeats of patterns 7, 8, 9 & 10)
++ (only lights again after power off and on again)



Full-size PC board artwork. Use this to check commercial boards or to make your own board.

0V supply terminals and measure the voltage between the metal tab of REG1 and pin 14 of the IC1 socket. This should be +5V. If this is correct, disconnect power and insert IC1, making sure it is oriented correctly.

Apply power again and check that the LEDs start to light up and produce a chasing pattern. The initial pattern is the KnightRider chaser (Pattern 1) with the LEDs moving from left to right and from right to left.

Check that you can adjust the speed with trimpot VR1 and vary brightness with VR2.

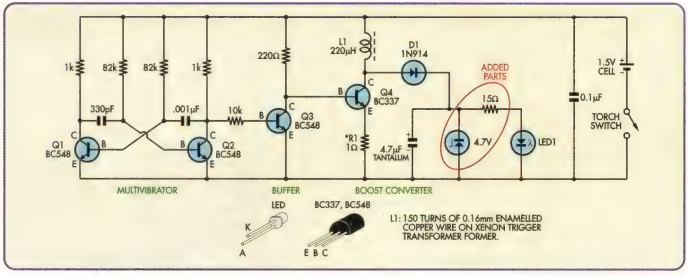
You can test for the other patterns by pressing the pattern switch. Each time you press the pattern switch, LED33 will flash the required number of times and then the selected pattern sequence will start to run.

You may need to adjust the speed trimpot (VR1) so that you can easily count the number of flashes from LED33.

Table 1 shows the 14 patterns available. **SC**

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Protection for white LED in torch

The article on the LED Torch published in the December 2000 issue warns against powering up the circuit without the LED and then subsequently connecting the LED. This can destroy the white LED from over-current due to the over-charged tantalum capacitor. While this should be a "remote possibility" because the LED is hard-wired into the circuit, in fact that LED-destroying condition can occur fairly easily.

The problem arises when the screw-type torch is used and the wire twists off, as it inevitably will, from screwing and unscrewing to change the battery (or what is more likely, to show other interested parties what is inside!). Then, when investigating why the LED will not light, the LED can make momentary contact again and will immediately blow from over-current.

The suggested fix limits the voltage across the tantalum capacitor with a 4.7V zener diode (which normally does nothing because the LED holds the zener below its operating voltage) and uses a 15Ω limiting resistor in series with the LED to ensure that it can be safely connected or disconnected and at no time exceed the 200mA rated absolute maximum peak LED current.

The 15Ω resistor does waste some power but this amounts to less than 10% and is well worth sacrificing to help provide a fail-safe circuit for the expensive LED.

The zener also protects the tantalum capacitor from over-voltage breakdown that can otherwise occur when the LED is not in circuit.

The total cost of the modification is less than 50 cents and the additional components can be mounted on the existing PC board.

Rick Matthews,
Adelaide, SA. ($30)

CONTRIBUTE AND WIN!

As you can see, we pay good money for each of the "Circuit Notebook" contributions published. But now there's an even better reason to send in your circuit idea: each month, the best contribution published will win one of these superb Wavetek Meterman 85XT true RMS multimeters - valued at around $380! So don't keep that brilliant circuit secret any more: send it to SILICON CHIP and you could be a winner!

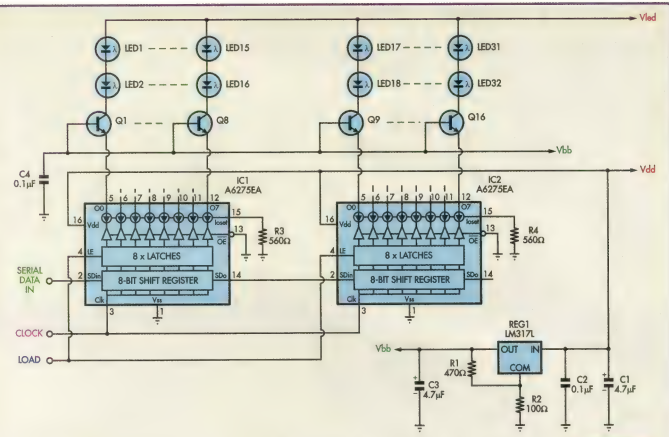
Contributions must be your own original work or a major adaptation and not published elsewhere nor submitted for publication elsewhere. SILICON CHIP's decision is final.

Relative field strength meter for a DMM

Many passive field strength meters have appeared in the past, typically using a 50µA analog meter movement if reasonable sensitivity was to be obtained. This circuit is similar but has the advantage that it works with the high-impedance load of a digital multimeter, typically switched to the 200mV range.

The sensitivity is adequate for low power equipment like CB radios, cordless phones and model R/C sets (cars, model airplanes, etc).

For best results, use OA81 or similar germanium diodes. Modern Schott-



Constant current LED drive

Most LED driver circuits use a series resistor to control the current through the LED. For applications needing a few LEDs, this is optimal. However, for applications needing many LEDs, this becomes extravagantly inefficient and it is tempting to keep the voltage drop across the resistor as small as possible. That leads to poor control of the current.

ICs such as the MM5450 and its relatives and the A6275 and its relatives provide constant current outputs so that the current through the LEDs is well controlled even though the voltage drop across the circuit doing the control is acceptably small. However, the difficulty with these circuits is that because they contain many constant current drivers crowded into a relatively small package, unless the supply voltage is small, they become too hot and can destroy themselves. This problem is not easy to solve.

The solution is to maintain a small voltage across each constant current source. In this circuit, this is accomplished by REG1, the LM317L, which provides a bias of about 1.5V ±5%. Each transistor works as an emitter-follower, presenting the A6275 inputs with about 0.9V. Vled, the LED supply voltage, needs to be high enough to ensure that there will be at least 0.5V across each transistor but it is safe to allow significantly more than this and the supply need not be well regulated.

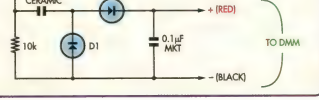
The transistors can be general purpose NPN types such as BC548 and a single LM317L will easily supply a total LED current of at least 1A. A6275s are made by Allegro and are available from Farnell, catalog numbers 300-5306, 300-5318.

Keith Anderson, Kingston, Tas.

ky signal diodes could also be used but the results are not as good.

The circuit can be wired directly into a small plastic box with protruding banana posts to match the terminals on your DMM. A banana jack can also be used for the antenna which could be just a 500mm length of wire as a starting point.

Gerard La Rooy, Christchurch, New Zealand. ($30)



BUILD THE BATTERY GUARDIAN

By JOHN CLARKE

Got a big stereo system in your car? Got a fridge in your van or 4WD? Ever had the battery discharged to the point where you couldn't start the motor? Not a good feeling, is it? You need our Battery Guardian. It monitors the battery voltage and will switch off the current to your fridge or stereo (or whatever) when the battery voltage falls below a preset level to allow you to still start your engine.

ELECTRIC FRIDGES IN VANS and 4WDs are a great idea but if you are not careful, they can severely discharge the battery and leave you stranded. Maybe the battery will end up with severe damage as well. The same problem applies if you have a big stereo system and you like to play it without the motor running.

Operation on 12V is fine when the motor is running and battery charge is maintained but if the fridge is allowed to run for too long when the motor is stopped, it can flatten the battery in a relatively short time. This is where the Battery Guardian comes into play. It monitors the battery voltage and disconnects power to the fridge before the battery becomes too flat to allow the engine to be started again.

Note that some fridges already have a low battery cut-out that prevents operation if the battery voltage goes below 10.5V. The cut-out is included for two reasons. One is to prevent the battery from being discharged to the point beyond which the battery life is reduced. The second is to prevent the fridge motor from stalling since it would not be able to drive the fridge pump at such a low voltage.

However, at 10.5V, no vehicle battery could start the motor and therefore you could easily be stranded way out in Woop Woop.

By contrast, the SILICON CHIP Battery Guardian disconnects the power when the battery voltage drops to about 11.5V. At this voltage, the battery should still have sufficient reserves to start the engine but you can set the cut-out voltage higher or lower to suit your vehicle.

The SILICON CHIP Battery Guardian has to operate without causing any significant additional current drain from the battery. If it did have a significant current drain, it would become part of the problem rather than being the solution. This fact means we cannot use a relay to control the power switching. A suitable automotive relay would draw some 120mA continuously when activated so clearly we had to rule this option out.

Instead of a relay, the Battery Guardian uses a power Mosfet and this cuts power consumption dramatically. In fact, the whole circuit draws an average current of less than 2.5mA.

Fig.1 shows the circuit. It uses three low-cost ICs, the power Mosfet and not much else.

MAIN FEATURES

- Cuts power to load (eg, fridge) when battery voltage drops below a preset level.
- 10A rating.
- Low power drain.
- Chirping sound during cut-out.
- Flashing LED indication during cut-out.
- Automatically reconnects power when battery recharged.

Mosfet Q1 provides the switching for the 12V rail (ie, between the 12V IN and the 12V OUT). This rail is fused using fuse F1 (10A), to protect against short circuits on the 12V output.

High side switching

One of the problems with using a Mosfet to switch +12V rail is that its Source and Gate electrodes cannot be connected to the 0V side of the supply. Instead, we are using the Mosfet as a "high side switch" (ie, switching the positive supply rail). This means that the gate voltage must be referenced to the source electrode of the Mosfet which rises to almost the full positive supply when the Mosfet is switched on.

Hence, we need to generate a gate voltage for the Mosfet which is tied to its source electrode and isolated from the 0V line. And Q1 needs a gate voltage which is at least 10V above its source in order to switch fully on.

This voltage is provided using an oscillator circuit (IC1) which drives transistor Q2 and a small step-up transformer, T1, wound on a ferrite toroid. The output of T1 is rectified using D1 and a 0.1µF capacitor (for filtering) to derive a signal which is fed to Q1's gate.

IC1 is a CMOS 7555 timer which is connected to operate in astable (continuous) mode. Its frequency of oscillation is set by the .0015µF timing capacitor on pins 6 & 2 and by the associated series 1MΩ and 1kΩ resistors on pin 7.

Using the timing components shown, IC1 runs at about 1kHz, with the charging time (.0015µF x (1MΩ + 1kΩ) x 0.693 = 1.04ms. By comparison, the discharge time is very short, around 1µs, since the 1MΩ resistor is not involved.

The pin 3 output of IC1 is high while the timing capacitor is charging and low when discharging (ie, the output is a pulse waveform with a high duty cycle). This pulse signal is inverted using NAND gate IC3a and

All the parts fit on a single PC board, so the circuit is easy to build. Note that the corners of the PC board must be removed to clear the corner mounting pillars inside the case.

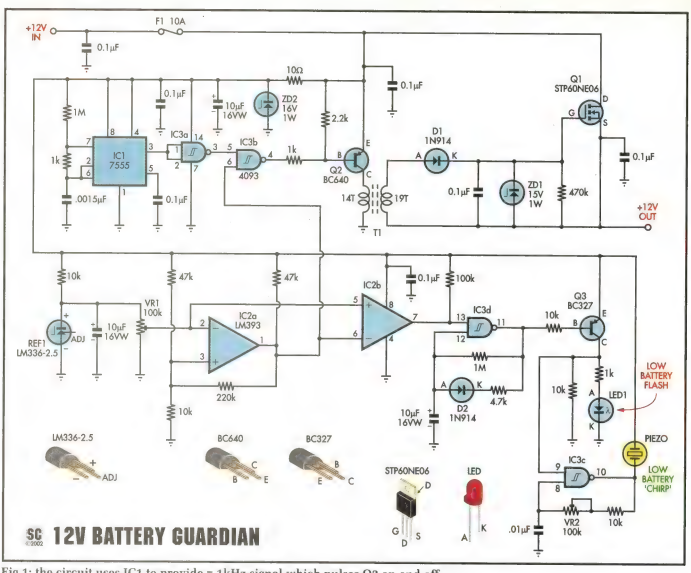


Fig.1: the circuit uses IC1 to provide a 1kHz signal which pulses Q2 on and off. Q2 in turn drives transformer T1, the output of which is rectified and filtered to provide a DC voltage to turn on Mosfet Q1. REF1, VR1 & IC2a set the cutoff voltage and provide the gating signal to IC3b.

inverted again using IC3b (assuming that pin 6 of IC3b is high).

IC3b drives the base of transistor Q2 via a 1kΩ resistor. As a result, Q2 switches on for about 1µs every 1ms and pulses the primary of transformer T1. The secondary of transformer T1 drives diode D1 and its associated 0.1µF filter capacitor and the resulting DC voltage turns on Mosfet Q1.

Zener diode ZD1 limits the gate voltage applied to Q1 to a safe value – ie, to no more than 15V between gate and source (or 27V above ground).

Q1's "on resistance" is typically .02Ω and this means that it will dissipate about 0.5W when supplying 5A to the load (eg, fridge or whatever). In addition, as the Mosfet turns off, it dissipates power as its gate voltage falls. In fact, the dissipation will be higher during this turn-off period (about 50ms), as its "on resistance" increases. For this reason, a heatsink has been used to ensure that the device runs cool.

Mosfet Q1 is switched off (to cut the power to the load) when pin 6 of IC3b is pulled low. This sets pin 4 of IC3b high and so transistor Q2 turns off (and remains off). As a result, the 470kΩ resistor between Q1's gate and source terminals discharges the 0.1µF capacitor over a 47ms period and the Mosfet switches off.

Voltage sensing

Pin 6 of IC3b is controlled by a voltage sensing circuit consisting of REF1 and comparator IC2a.

REF1 is a 2.5V voltage reference and is supplied with current via a 10kΩ resistor from the 12V rail. Its 2.5V output is attenuated by trimpot VR1 (which sets the cut-out voltage) and applied to the inverting input (pin 2) of IC2a. At the same time, the non-inverting input (pin 3) monitors the supply voltage via a voltage divider consisting of 47kΩ and 10kΩ resistors.

Normally, with a fully charged battery, the voltage on pin 3 is greater than that on pin 2 and so pin 1 is high. As a result, pin 6 of IC3b is also high and so IC3b gates through the pulses from IC1 to Q2, as described previously. The 220kΩ feedback resistor between pins 1 & 3 of IC2a provides a small amount of hysteresis, so that IC2a switches cleanly at the cut-out setting.

The resistors connected to pin 3 set the voltage at this pin to about 1/5Vcc

(ie, one fifth of the supply voltage). This means that if we want Q1 to switch off at 11V, we have to set VR1 so that pin 2 is at 2.2V. When pin 3 falls below this voltage (ie, as the battery voltages falls below 11V), pin 1 of IC2a goes low and so IC3b blocks any further pulses from IC1 and IC3a.

As a result, Q2 remains off and so Q1 also turns off and disconnects power to the load (ie, the fridge).

At the same time, the low output at pin 1 of IC2a pulls pin 3 down to 1.86V, since the 220kΩ feedback resistor and 10kΩ resistor are now effectively in parallel. The voltage on pin 3 is now effectively 0.169 x Vcc, which means that the battery voltage must now go above 13V before the voltage at pin 3 equals the 2.2V at pin 2 and pin 1 switches high again.

Without the hysteresis provided by the 2.2MΩ feedback resistor, pin 1 would simply cycle rapidly between high and low as the battery voltage recovered each time the fridge load was removed.

Note that REF1 has a 10µF capacitor across it. That's there to ensure that REF1's output is initially low when power is first applied, so that pin 1 of IC2a is high. Pin 1 of IC2a will then go low again if the supply voltage is below the cut-out value set by VR1 but only when REF1's output has settled to its correct value – ie, after the capacitor has charged via the 10kΩ resistor.

Indicator circuitry

As well as controlling pin 6 of IC3b, IC2a also drives the inverting input (pin 6) of comparator IC2b. As shown, IC2b's non-inverting input is connected to VR1's wiper, which means that it is nominally at 2.2V.

When pin 1 of IC2a is high (ie, Q1 on), IC2b's output at pin 7 is low and so NAND gate IC3d and any following circuitry is disabled. However, when pin 1 of IC2a goes low (ie, to turn Q1 off), pin 7 of IC2b goes high and allows NAND gate oscillator IC3d to operate.

The feedback components between pins 11 & 12 and the associated 10µF timing capacitor set the frequency of the NAND gate oscillator. To understand how this works, just remember that the output of a NAND gate only goes low when both inputs are high.

Assume initially that Mosfet Q1 is on. This means that pin 7 of IC2b and thus pin 13 of IC3d are low and so pin 11 of IC3d will be held high.

Pin 12 of IC3d will also be high during this time, since the 10µF timing capacitor will charge via the 1MΩ feedback resistor. At the same time, PNP transistor Q1 will be off (since its base is held high by pin 11) and so both LED1 and the piezo siren will also be off.

OK, now let's see what happens when the Mosfet (Q1) switches off. When that happens, pin 7 of IC2b goes high and pin 11 of IC3d switches low. The 10µF timing capacitor now discharges into this low output via D2 and a series 4.7kΩ resistor until it reaches the logic low threshold of pin 12. When that point is reached, pin 11 of IC2b switches high again and recharges the 10µF capacitor via the 1MΩ feedback resistor, whereupon pin 11 switches low again.

This cycle continues while ever pin 13 of IC3d is high, with the 10µF timing capacitor charging via the 1MΩ resistor and discharging via D2 and the 4.7kΩ resistor (ie the capacitor discharges far more quickly than it charges). As a result, pin 11 of IC3d is high for about 10s and low for about 10ms during each complete cycle.

Each time pin 11 pulses low, Q3 turns on and briefly flashes LED1. It also briefly enables NAND oscillator IC3c (by pulling pin 9 high). This oscillator runs at around 1-2kHz (depending on the setting of VR2) and briefly drives the piezo siren.

As a result the piezo siren briefly "chirps" and the LED flashes once every 10 seconds to let you know that the power to the load (fridge) is "off".

Unlike NAND gate oscillator IC3d, IC3c runs with an even duty cycle, since its .01µF timing capacitor both charges and discharges via VR2 and its series 10kΩ resistor. In practice, VR2 is adjusted so that the frequency is the optimum for the piezo to produce its loudest output.

Power for IC1, IC2 and IC3 is derived from the incoming 12V supply rail via fuse F1 and a 10Ω resistor. Further supply decoupling is provided by several 10µF and 0.1µF capacitors, while zener diode ZD1 protects the circuit from voltage transients by clamping any spike voltages to 16V.

Construction

All the parts for the Battery Guardian are mounted on a single PC board, so it's a snack to build. This board is coded 05106021 and measures just 122 x 60mm. The completed assem-

Parts List

1 PC board, code 05106021, 122 x 60mm
1 plastic case, 130 x 67 x 44mm
1 front panel label, 129 x 67mm
1 piezo transducer (Jaycar AB-3440 or equivalent.)
1 4-way PC mount terminal strip (Altronics P-2103)
1 mini-U heatsink, 19 x 19 x 10mm
1 ferrite toroid, 17m OD x 10mm ID x 6mm (Jaycar LO-1230 or equivalent.)
1 10A 3AG fuse
2 PC-mount 3AG fuse clips
1 1m length of 0.25mm enamelled copper wire
1 200mm length of 0.8mm tinned copper wire
1 M3 x 6mm screw
1 M3 nut
2 M2.5 x 9mm screws
2 PC stakes
2 100kΩ horizontal mount trimpots (code 104) (VR1,VR2)

Semiconductors
1 7555 CMOS timer (IC1)
1 LM393 dual comparator (IC2)
1 4093 quad Schmitt NAND gate (IC3)
1 STP60NE06 60A 60V N channel Mosfet (Q1)
1 BC640 NPN transistor (Q2)
1 BC327 PNP transistor (Q3)
1 LM336-2.5 reference (REF1)
1 15V 1W zener diode (ZD1)
1 16V 1W zener diode (ZD2)
2 1N914, 1N4148 switching diodes (D1,D2)
1 5mm high-brightness red LED (LED1)

Capacitors
3 10µF 16VW PC electrolytic
7 0.1µF MKT polyester
1 .01µF MKT polyester
1 .0015µF MKT polyester

Resistors (0.25W, 1%)

2 1MΩ	5 10kΩ
1 470kΩ	1 4.7kΩ
1 220kΩ	1 2.2kΩ
1 100kΩ	3 1kΩ
2 47kΩ	1 10Ω

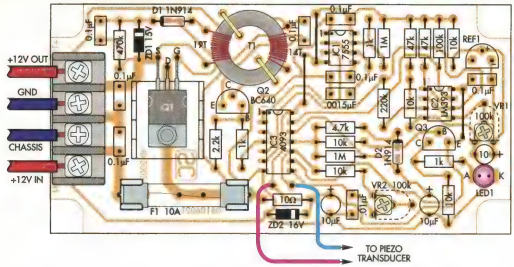


Fig.2: follow this diagram when installing the parts on the PC board. Take care to ensure that transformer T1 is correctly oriented – it is secured to the PC board using a couple of wire loops.

bly then fits neatly inside a standard plastic case measuring 130 x 67 x 44mm (see photo).

Start by inspecting the PC board for shorted tracks or breaks in the copper by comparing it with the published pattern. While you're at it, check that the holes are large enough for the component leads, particularly for the screw terminals.

Note also that the corners of the PC board must be shaped as shown on the PC layout diagram (Fig.2), so that it can be fitted into the box – ie, the corners have to be removed to clear the integral mounting pillars. You can remove the corners by first cutting out a rectangular piece using a small hacksaw and then carefully filing to shape using a round file.

Alternatively, you can use a minidrill fitted with a small grinding disk (eg, a Dremel tool, or similar).

Fig.2 shows how the parts are fitted to the PC board. Begin by installing the three wire links plus two PC stakes to terminate the wiring from the piezo transducer. This done, install the resistors in the positions shown.

Table 1 shows the resistor colour codes but we recommend that you also check each value using a digital multimeter as some of the colours can be difficult to decipher.

Diodes D1 & D2 can go in next, followed by zener diodes ZD1 and ZD1. Take care to ensure that these are all installed the right way around and don't get ZD1 & ZD2 mixed up (their voltages are different).

Now for the three ICs. These are all soldered directly to the PC board, again making sure that they are oriented correctly. It's easy to identify pin 1 on each IC – it will be adjacent to a notch or dot at one end of the body.

Next, install the capacitors, taking care to ensure that the electrolytics are oriented as shown. That done, the transistors can go in but don't get Q2 and Q3 mixed up – Q2 must be a BC640, while Q3 is the BC327.

The Mosfet transistor (Q1) is mounted horizontally on a small heatsink and is secured using a 10mm M3 screw and nut. This means that you have to bend Q1's leads down by 90° before installing it on the board.

This is best done by first slipping an M3 screw through the device tab, positioning it on the board and then gripping one of the leads with a pair of needle-nose pliers just before it reaches its mounting hole. The device is then lifted clear of the board, the lead bent at right-angles and the procedure then repeated for the remaining two leads.

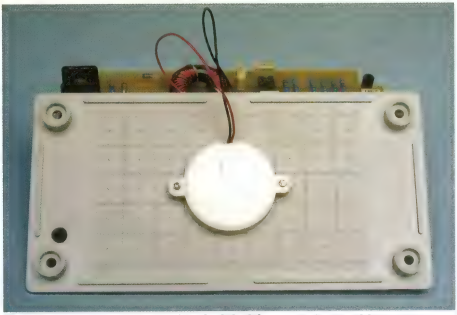
Once all the leads have been bent,

Table 2: Capacitor Codes

	Value	IEC Code	EIA Code
❑	0.1µF	104	100n
❑	.01µF	103	10n
❑	.0015	152	1n5

Table 1: Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	1MΩ	brown black green brown	brown black black yellow brown
❑	1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	5	10kΩ	brown black orange brown	brown black black red brown
❑	1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	3	1kΩ	brown black red brown	brown black black brown brown
❑	1	10Ω	brown black black brown	brown black black gold brown



The piezo transducer is secured to the lid of the case using two M2.5 x 10mm screws. Before mounting it, drill a small hole directly in front of the element, to let the sound escape.

the device can be secured to the PC board with its heatsink and the leads soldered. Note that it's not necessary to isolate the tab from the heatsink, since the heatsink doesn't touch any other parts. However, because Q1's tab is connected to its drain terminal (which is connected to the +12V rail), this means that the heatsink will be at +12V when the circuit is operating.

The PC board assembly can now be completed (except for transformer T1) by installing the 4-way screw terminal block, the fuse clips (make sure these go in with the retaining flanges towards the outside), pots VR1 & VR2 and the LED. The latter should be mounted so that the top of its plastic body is 30mm above the PC board.

By the way, we've provided two sets of mounting holes for the right-hand fuse clip, so that you can use either a 3AG fuse or the shorter M205 type (the position shown on Fig.2 is for a 3AG fuse). Unless you have a good reason to do otherwise, stick with a 3AG fuse as these are more commonly available from service stations (note: M205 fuse clips are smaller).

We've also designed the board to accept the two commonly available trimpot sizes for VR1 and VR2. It's up to you which type you use.

Winding the transformer

The primary and secondary of transformer T1 are wound on a ferrite toroid as shown in Fig.3. Wind on 14 turns of 0.25mm enamelled copper wire for the primary, in the direction shown. Similarly, wind on 19 turns for the secondary, in the direction shown.

Once the coils have been wound, scrape away the enamel from the ends of the leads and install the unit on the PC board. Make sure that you get the

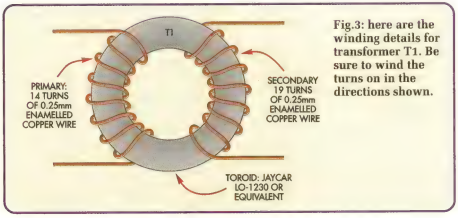
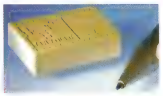


Fig.3: here are the winding details for transformer T1. Be sure to wind the turns on in the directions shown.

The Tiger comes to Australia

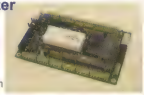


The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.

Tigers are modules running true compiled multi-tasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I^2C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

JED makes four Australian boards with up to 64 screw-terminal I/O, more UARTs & LCD/keyboard support. See JED's www site for data.

TIG505 Single Board Computer



The TIG505 is an Australian SBC using the TCN1/4 or TCN4/4 Tiger processor with 512K FLASH and 128/512K RAM. It has 50 I/O lines, 2 RS232/485 ports, SPI, RTC, LCD, 4 ADC, 4 (opt.) DAC, and DataFLASH memory expansion. Various Xilinx FPGAs can add 3x 32bit quad shaft encoder, X10 or counter/timer functions. See www site for data.

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software. **Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.**

JED Microprocessors Pty Ltd
173 Boronia Rd, Boronia, Victoria, 3155
Ph. 03 9762 3588, Fax 03 9762 5488
www.jedmicro.com.au

Fig.4: this full-size artwork can be used as a drilling template for the front panel.

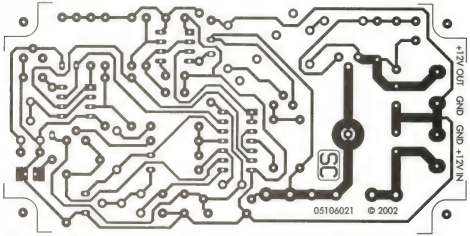


Fig5: this is the full-size etching pattern for the PC board. Check your board carefully before installing any of the parts.

windings the right way around, with the primary towards IC1 and the secondary towards Q1. The toroid is then secured using short lengths of tinned copper wire which loop over either side of the core and solder to the PC board (see Fig.2).

Final assembly

There's not much to the final assembly, apart from drilling a few holes in the case and clipping the PC board into position.

The first step is to affix the front panel label to the lid. The label can then be used as a template for drilling the mounting holes for the LED (3mm) and the piezo transducer (2.5mm). You will also have to drill a small hole in front of the piezo transducer to let the sound out.

You also have to drill four holes in one end of the case, in line with the screw terminal block. This is best done by clipping the board into the integral slots in the case, marking out the hole positions, then removing the board and drilling the four holes to accept the power cables.

Once all the holes have been drilled, clip the board back into the case and mount the piezo transducer on the lid using two M2.5 x 10mm screws. The transducer's leads can then be soldered to the two PC stakes on the PC board.

Finally, install the fuse and you're ready for the smoke test.

Testing

Before applying power, check the assembly carefully to make sure that all parts are installed correctly. That done, apply power from the battery and use your multimeter to check for +12V on pin 8 of IC1, pin 8 of IC2 and pin 14 of IC3.

Assuming these are correct, check the voltage between Q1's gate and the "+12V IN+" terminal (positive lead to Q1's gate). You should get a reading of either 15V or 0V, depending on VR1's setting. If you get a reading of 0V, rotate VR1 anticlockwise until the reading jumps to 15V.

If the voltage only reaches a volt or two when you rotate VR1, check that you have wound T1 correctly. If you wind one of the windings in the wrong direction, the windings will operate in anti-phase.

Now adjust VR1 clockwise until you get a reading of 0V. LED1 should now flash once every 10 seconds or so and the piezo transducer should chirp when the LED flashes. Adjust VR2 for the best sound from the transducer.

Setting the cut-out voltage

Assuming it's all working correctly, VR1 can now be used to set the cut-out voltage (ie, the battery voltage at which the fridge is disconnected).

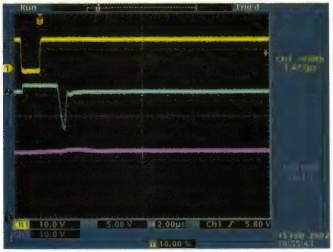
Table 3 shows how to set VR1 for various cut-out voltages from 10.5V to 11.7V. It also indicates the remaining battery capacity for each of these voltages but note that these are typical figures only and are not precise.

Basically, it's just a matter of selecting the desired cut-out voltage and adjusting VR1 to get the correct reading on the wiper. So, if you want to set the cut-out voltage to 11.5V, for example, adjust VR1 for 2.3V on its wiper (ie, 2.3V between the wiper and ground).

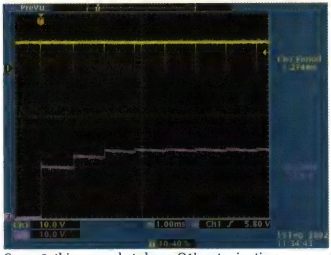
Generally, a cut-out voltage of about 11.5V or 11.6V is the way to go, since

TABLE 3: SETTING THE CUTOUT VOLTAGE

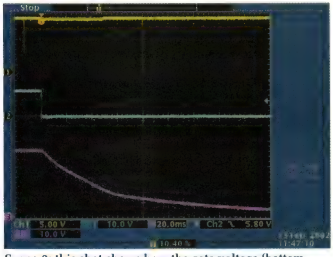
Remaining Battery Capacity	Battery Cutout Voltage (Typical)	Voltage Required To Reapply Power	VR1 Setting (Voltage At Pin 2 of IC2)
0%	10.5V	12.4V	2.1V
10%	11.0V	13.0V	2.2V
15%	11.2V	13.25V	2.24V
20%	11.5V	13.6V	2.3V
25%	11.6V	13.7V	2.32V
30%	11.7V	13.8V	2.34V



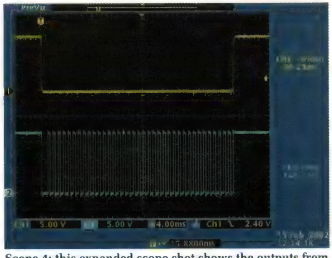
Scope 1: the top trace shows the low-going output from pin 4 of IC3b (it is low for 1.47µs), while the middle trace shows the collector of Q2 which is pulled to the 12V supply when switched on via a low-going signal from IC3b. When IC3b goes high, the collector goes below ground due to the back EMF produced by the primary of T1. The lower trace is the voltage on Q1's gate which is about 26V above ground (14V above the 12V supply rail).



Scope 2: this scope shot shows Q1's gate rise time following the first low-going signal from NAND gate IC3b. The top trace shows IC3b's output at pin 4, while the lower trace shows Q1's gate voltage. Notice how the gate voltage reaches 20V (8V above 12V) the instant IC3b's output goes low and high again. The full gate voltage is reached after about four pulses from IC3b – a period of around 4ms.



Scope 3: this shot shows how the gate voltage (bottom trace) falls when pin 1 of IC2a switches low (middle trace). As shown, the gate voltage on Q1 falls slowly (via the associated 470kΩ resistor) over a period of about 100ms.



Scope 4: this expanded scope shot shows the outputs from IC3d (top trace) and NAND oscillator IC3c (bottom trace). The output from IC3d is 30ms wide and drives LED1, while IC3c drives the piezo transducer. Its frequency here is 746Hz (as set by VR2).

this leaves about 20% battery capacity in reserve for starting the car's engine. However, you can set the cut-out voltage higher or lower than this to suit your own particular requirements.

Installation

The Battery Guardian simply connects in-line between your car's cigarette lighter socket and the fridge (or load). Your fridge will already be fitted with a cigarette lighter plug and this can be removed and transferred across to the Fridge Cutout's input power leads. The fridge itself is then connected to the top two terminals of the screw terminal block.

Be sure to use automotive power cable for all supply connections to and from the Battery Guardian.

Do not connect the Battery Guardian directly to the battery. If you don't wish to use the cigarette light socket, the +12V supply should be taken from a fused (but unswitched) terminal on the fusebox.

Note that if you wish to use the Battery Guardian with a large car stereo system, you cannot power all the amplifiers via the circuit because they are likely to draw more than 10A, which would exceed the fuse rating. Instead, the Battery Guardian would be connected in line with the supply to the head-end unit; ie, the CD/tape/tuner unit. That way, if the battery drops below the threshold, the head-end unit will be cut off and so the current drain from the amplifiers in the system will drop to a low value.

Finally, the Battery Guardian could also be used to protect the batteries in a 12V lighting system, with the over-all current limit again set by the 10A fuse. **SC**

SERVICEMAN'S LOG

Stubbornness or tenacity of purpose?

Regardless of the motive, there is much to be said for the habit of "sticking with it", when not all the symptoms match. Taking the easy way out can have adverse consequences.

My first story this month is about a Teac EU-68St which employs an 11AK19 chassis. This is a 68cm silver-coloured stereo TV set, manufactured in Turkey around January 2000. I was surprised to see it come into the workshop, as it looked brand spanking new.

I could tell from the owner's face that he was extremely upset; it was no longer under warranty and it had failed so soon. However, when I took down the details of his address, an absolute water frontage on the beach, I wasn't so surprised.

The set was dead and it didn't take long to diagnose a shorted horizontal output transistor (Q605, BU2508D). This was due to an overheating horizontal output transformer (TR602), no doubt hastened to its demise by the layer of salt deposited by the onshore winds. In fact, most of the metal screening cans were already rusty.

An order was placed for the parts and a service manual and they arrived some time later. When the parts were installed and the set switched on, I was faced with a new symptom – no vertical deflection. As a result, a new vertical output IC (IC701, TDA8351) was ordered.

This duly arrived and was fitted only to produce symptom number three: no picture, just a raster with retrace lines.

This time, I knew I would be faced with a difficult problem and that I would have to consult the service manual. Unfortunately, this document is somewhat disappointing and mainly consists of 29 pages of a detailed "Bill of Material List". The circuit and PC board layout diagrams were also difficult to follow, being rather poor photocopies.

Because the problems with this set had all started with the horizontal output transformer, I was looking for components that might have been destroyed by the breakdown. With that in mind, I started by checking the beam current and ABL (Automatic Brightness Limiter) circuit. This is easier said than done because the main PC board is small and carries unmarked surface mount components on the copper side and normal-size parts on the other.

As can be imagined, the assembly is quite compact, which makes it difficult to trace the circuit. Anyway, that circuit eventually checked out OK.

One of the vital symptoms I noticed was that there was no OSD (On Screen Display). This suggested that the problem was likely to be affecting the video output rather than the small signal circuits from the tuner/IF onwards. In an effort to isolate the problem area, I connected a monitor to the AV output socket and found, with some mucking about, that I could get a clear full-colour picture on it from the tuner.

Next, I connected a colour bar generator into the video output sockets but could not display that on either the TV set or the monitor, regardless of what I did with the remote control. I then measured horizontal pulses and the sandcastle on pin 41 of the jungle IC (IC401, TDA8844/N2) and checked all seven of the voltage rails from the power supply with the CRO, looking for excessive ripple.

I also checked the five voltage rails sourced from the horizontal output transformer and these were all OK.

My next step was to check for the blanking pulses from IC501 (SDA545XOTP) but I couldn't detect them. But when I unsoldered pins 23, 24 and 25 of IC401, they reappeared. This was enough proof for me that the jungle IC was crook, so I ordered a new one.

However, when it arrived, I was disappointed to find it made absolutely no difference. It was only then that I found that these pulses were there only when the OSD was on (although I couldn't see this on the screen) – pressing the menu button would produce the pulses.

From here on in, things just became worse. I was following one blind alley after another and pursuing all sorts of strange and wonderful theories. There are a lot of circuits in this set. And it's not obvious what all of them do. For example, I couldn't work out the function of Q425 and Q426; a possible spot suppressor – who knows?

I phoned Teac for technical support and they suggested that I replace C604 (.047µF) on the beam limiting line from the horizontal output transformer. I did this but it made no difference.

Back off mate!

To be honest, I was close to quitting and returning the set to the customer. This elusive fault was eating into my time and the repair was becoming uneconomic, even for a fairly new TV set. In the meantime, the customer was pressuring me to fix the problem quickly but it doesn't work like that

with this type of problem. You need space and time and the pressure tactics don't work.

Knowing that it's probably an insignificant little part that's causing the problem doesn't help either. And neither does the customer's implication that I don't know what I'm doing – even if I don't!

And then, suddenly, there was a clue. I was running my finger across IC401's pins (the jungle IC) and, somewhere around pin 22 & D701, the picture nearly appeared. Encouraged, I renewed my investigation into this area, even though I previously could not find anything wrong with it. And I now noticed that although the DC voltage and amplitude waveform didn't change much, the width of the vertical pulse changed.

I traced the circuit back via Q701 and ended up back at the vertical IC (IC701).

At this point, I also noticed that the blank raster wasn't perfectly linear in the vertical deflection and neither were the retrace lines, especially at the top. So was the new vertical IC faulty?

Well, before I replaced it again, I measured the DC voltage and checked the waveform on each of its nine pins. When I reached pin 6, I noticed that this was at 20V or so, despite being fed via a 100Ω resistor (R704) from a 45V rail. This meant that another 20V was being developed across R704, which struck me as a much too high a voltage across a 100Ω resistor, considering the likely current level in this part of the circuit.

I removed R704, a 1% metal film type, and measured it. It was nearly 5kΩ. I fitted a new 100Ω resistor in its place and the rest, as they say, is history.

The picture was fully restored, although it required adjustments to the screen voltage and focus settings. The OSD appeared as expected and when I investigated the menu system, I found I could switch the 'AV-OUT' from 'TV' and the other 'AV-IN' sockets. I think, in retrospect, I should have been more observant and followed the likely path of the sparking horizontal output transformer and the vertical output IC failure – but it's easy to be smart after the event.

Blaupunkt MS-70-109 VTM

I have had a few Blaupunkt sets in

Items Covered This Month

- Teac EU-68ST TV set.
- Blaupunkt MS-70-109.VTM TV set.
- Mitsubishi HS-E11(A) VCR.
- IBM Thinkpad T20 computer.
- Troubleshooting an Internet connection.

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recently, all about 10 years old. The fact that I rarely see them younger than that indicates how reliable they are. I am pretty sure, too, that they are now all made by Grundig.

The Blaupunkt in this case was an MS 70-109 VTM, using an FM 500-70 (7 669 840) chassis (probably equivalent to a Grundig 29701-057). Like most German sets it is somewhat upmarket, with a remote controlled motorised swivel base, sub-woofer, Toptext and menu system, etc. And, of course, it was as dead as a dodo.

In our hot humid climate, most faults start at the set's high voltage end and create further damage from there. Its owner had lost track of how old it was and as this was the first time it had broken down, he just told me fix it as soon as possible.

I initially diagnosed a faulty tripler (yes, there are still a few about), a faulty horizontal output transformer, and a crook horizontal output transistor (BU508AG, T541). The avalanche of faulty parts then continued with the horizontal oscillator driver IC (IC500, TDA8140), electrolytic capacitors C541 and C507, the east/west modulator diode (D546), C573 (0.36µF), plus collateral damage in the small signal circuits – eg, IC7010 and D7012 on the east/west deflection correction module.

All in all, this set was very sick but this bloke was determined – he wanted it fixed.

I replaced all the above parts plus IC500 and a few extra horizontal output transistors. I used a BU508A for the horizontal output transistor and the extra ones were due to a few mishaps which I won't go into here. I also found some electrolytic capacitors on the deflection correction module that were in dire need of replacement and there were poor joints everywhere – not surprising given the age of the set.

Anyway, after a lot of kerfuffle, up came a first class picture. I soak tested the set for a few days and then told the customer to come and pick it up. I then thought that I had better check the Teletext – there was nothing and neither was there any menu system. And so, after a hasty rearrangement of the pick-up schedule, the set landed back on the bench.

From what I can make out from the circuit, all the menu and text action comes (naturally enough) from the Teletext module. However, I noticed that after the set had been running for a while, I could just see a faint image in the background. I also noticed that vertical hold was rolling slowly in the text and menu modes.

Without extension leads, it is hard to work close to these modules. Nevertheless, with the hairdryer switched to high (I nearly melted the set), I found that I could almost recover a fully working Teletext (actually Blaupunkt Toptext) and menu system. Unfortunately, I couldn't quite pinpoint the culprits by then applying freezer.

I next measured the voltages applied to the text module and replaced all the electrolytic capacitors on this board but this made no difference. However, I did find one thing – while checking the voltages, I decided to make more space for the probes by removing the AV module (socket board), which I thought was redundant for the time being.

Amazingly, removing this module restored both the text and the menu but the colours weren't right because there was a red caste all over the text picture. There isn't a lot on the AV module – mostly analog switching ICs and transistors. The RGB lines go to SCART socket 1 and are terminated with 75Ω resistors. And I found that hanging an extra 75Ω resistor across R233 restored everything.

It would have been easy to stop there – one resistor fixes the problem; go home. But this would smack of the stripped apron approach. There had to be a real reason for all this and I was curious.

The original resistor measured perfectly OK, so I removed and cleaned the SCART socket itself, as well as the plug that fits into the main chassis. However, these proved to be OK. The only other thing in common with this socket was the U DATA line which feeds the AV module, the chroma module, transistor T364 and socket P15. I decided to check this out more carefully and my patience was quickly rewarded when I found that T364 (BC548B) was open circuit. Unfortunately, a new one made no difference, much to my dismay.

Next, I checked the other transistors (T361, T366 & T363) on the motherboard and followed the line all the way to the control unit module and to IC830 (UAA2022). I found that unplugging BP1 also "fixed" the problem but that left a blue caste this time (this line is called U screen B). Plug BP1 connects pin 3 of IC830 with the rest of the circuit and replacing IC830 made no difference. I also checked T2817 and IC2860 on the text module by substitution but this achieved nothing.

By now, I was really quite tetchy over all this – I had come so far and fixed so much but this elusive fault remained. There wasn't much left to test on the U DATA line – only the chroma module and I felt it was highly unlikely to be that as the picture and colour were perfect.

Nevertheless, I persevered and re-

placed IC5200 (TDA3505), as pin 11 is directly connected to U DATA.

That was it! Apparently, pin 11 is the pole for the analog switch that switches between TV and text, and it wasn't toggling properly. It had probably been damaged by spikes from the tripler, along with all the other parts.

All the other temporary fixes were just red herrings. This really was a beast of a fault but it was worth "sticking with it".

Mitsubishi VCR

I had an interesting problem with a Mitsubishi HS-E11(A) VCR, employing an Fo deck. The tracking was out because a white plastic roller on the exit guide had seized on its shaft.

I found that by freezing the stainless steel shaft, I could free it so that it would rotate even if I just blew on it. But once it returned to room temperature I had to use a lot of strength to rotate it at all.

I asked a knowledgeable friend who does a lot of VCRs what he did in these circumstances. His answer was to wick in some 3-in-1 oil at the top and bottom of the roller. So I duly tried that but all I succeeded in doing was make a mess with oil everywhere. The guide was still seized. I even froze it and then applied the oil but it always seized again.

Finally, I tried heating it with a hairdryer for a long time until I couldn't touch the metal any more. The roller was seized hard but back at room temperature, it was beginning to feel a little freer.

I then cleaned it with "metho" to remove all the excess oil and lo and behold, it freed up completely. Well, this poses more questions than it answers.

Had the roller seized because the plastic had contracted with time, or had the lubricant (if it used a lubricant) dried up inside? By cooling it, the shaft diameter shrank enough to free it. So, when it was heated, did the shaft expand enough to stretch the plastic? Or was it just that the "metho" dissolved any dried out lubricant?

Sorry, I don't have the answers but perhaps someone else does. Anyway, it fixed the problem.

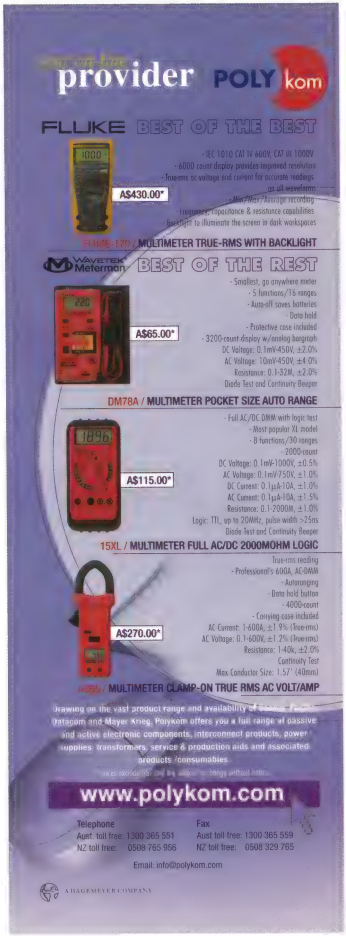
PS: a new roller assembly would require a lot more effort and money to install and align than the machine is worth.

Computer problems

I had two interesting computer problems this month, the first involving an IBM Thinkpad T20, Type 2647 (Pentium III-700) belonging to a student. Its operating system was Windows XP Pro v2002.

The problem was that it wouldn't boot at all, either from a floppy, a CD or the 9.3GB hard drive. Neither could I get into the BIOS setup. The only thing I could see was the opening Thinkpad flash screen with an F1 option to go into the BIOS or F2 to select a bootable device. Selecting either would cause the computer to go to a blank screen and hang.

My approach to fix it was to remove the power supply, the main battery and the memory battery and switch on. Obviously, nothing happened! But when I then replaced them all and switched on again, everything now worked. XP took some time to boot up but running CHKDSK/F on the next boot automatically fixed things.



Serviceman's Log – *continued*

How it had happened I could only guess. No viruses were detected later and a few files were found to be corrupted; eg, dsprov.dll, esscli.dll and framedyn.dll. There were also four bad clusters but nothing that couldn't fixed.

Internet access problem

The second problem actually happened to my own machine. It's pretty ancient (to match its impecunious owner) but it can just handle Windows Me. The problem I had was being unable to access the Comsec (Commonwealth Securities) website in order to flog some shares to pay the overdraft.

Unfortunately, each time I attempted to go to this website, IE5.5 asked if I wanted to go to a secure site before timing out and displaying a "Page Unavailable" message. But much to my frustration, I could browse other websites.

I then tried accessing http://www.comsec.com.au by following links from other sites (such as Netbank) but got nowhere. Eventually, after trying lots of other things, I swallowed my pride and sought help from both Comsec and from my ISP (Internet Service Provider), Zip Australia (now Pacific Internet).

At their prompting, I upgraded my browser to IE6 (plus updates), deleted all my temporary files and history, reset my defaults and set the security level to medium. But it made no difference.

We then tried a few fancy tricks like running a trace test at DOS level:

c:/>tracert www.comsec.com.au> c:\trace.txt. This produced a route to this website over a maximum of 30 hops which I then emailed to Comsec and Pacific Internet. I tried entering http://203.202.9.126 (Comsec's IP number) directly into my web browser but that didn't work either.

I was then advised to try http://www.commsec.com.au/Public/Content/CMD-ServiceDifficulties.asp. This failed the "Secure Connection" test and indicated either an SSL (Secure Socket Layer) or proxy setting fault.

I messed about with various proxy settings but it made no difference. Comsec were very helpful and came up with a 5-page screed on how to set up your browser for secure commercial sites. I tried everything on the list but nothing worked.

Finally, David Luger, Network Development Manager of Pacific Internet, was the one to crack it. He noticed that I had an incorrect DNS (Domain Name Server) entry (a DNS server links domain names to IP addresses).

When you do a "ping" or a "tracert" for a domain name, the system shows the IP address it is trying to access. And mine was selecting the wrong one. In fact, he noticed that mine was always looking up an obsolete address.

Anyway, David Luger suggested that this might be due to some "Internet acceleration software" that I may have previously installed, with the system now storing an old lookup address. This was beginning to ring some bells with me.

To track down the problem, he told me to try this at the DOS prompt from the root directory: dir/s hosts.*. This came up with three "hosts" files: hosts.tpx, hosts.sam and hosts.

The first two are sample Seagate and Microsoft files but the last one – c:\windows\hosts – was created by Modem Wizard (the Internet acceleration software I had installed). A "hosts" file, by the way, is nothing more than a simple text file that stores domain names and their corresponding IP addresses. It allows the system to bypass a DNS server for any domain names that are listed, thereby providing faster lookup (in effect, the hosts file acts as a local DNS).

Unfortunately, this list was now out of date – at least as far as the Comsec website was concerned. So, on David's advice, I simply renamed this file and tried Comsec again.

This time there was no problem and I had full access to the secure site. So, thank you, David. Nice one. **SC**

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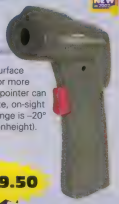

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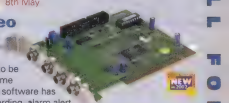

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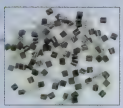

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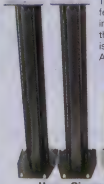

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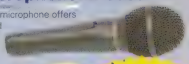

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SAVE $6

NOW $15.95

3 x RCA Plug - 3 x RCA Plug 1.5m
High quality 100% shielded OFC copper cables with moulded gold plated RCA plugs at each end for audio/video applications
Cat. WQ-7234
WAS $29.95

SAVE $5

NOW $24.95

Scart Plug - 6 x RCA Plug 1.5m
High quality 100% shielded OFC copper cables with moulded gold plated SCART & RCA plugs for audio/video applications.
Cat. WQ-7242
WAS $37.95

SAVE $8

NOW $29.95

3.5mm Stereo Plug - 2 x RCA Plug 1.5m
High quality 100% shielded OFC copper cables with moulded gold plated 3.5mm plug & RCA plugs for connecting a Walkman to your HI-FI.
Cat. WQ-7206
WAS $14.95

SAVE $3

NOW $11.95

Mains Charger

NEW

Will charge batteries* inside the 40 channel communicator.
Cat. DC-1014
*4 x AAA nickel metal hydride batteries required. Use SB-2444 $3.59ea

$14.95

Large Button Remote

This 3 in 1 remote is pre-programmed for use with thousands of different TV's, VCR's and Cable TV Models. The remote features large easy to read and use, rubber buttons.
Requires 2 AAA batteries.
Cat. AR-1710
WAS $29.95

$24.95

SAVE $5

SAVE $$$ ON OUR DISCONTINUED PRODUCT SELLOUT

Cat. No.	Product Description	WAS $	NOW $	SAVE $
AR-1700	MINI REMOTE CONTROL P/PROG	34.95	**29.95**	5.00
AR-1802	WIRELESS A/V SENDER 10mW	199.00	**189.00**	10.00
AR-1805	REMOTE CONTROL EXTENDER	89.95	**79.95**	10.00
AR-1806	A/V SENDER WITH REMOTE EXT	239.00	**219.00**	20.00
AR-1807	SPARE RECIEVER FOR AR-1806	129.00	**114.95**	15.00
AA-2006	CD STEREO HEADPHONES	20.95	**14.95**	6.00
AA-2024	NOISE CANCELLATION HEADPHONES	79.95	**59.95**	20.00
AA-2025	CELLPHONE HANDSFREE EAR + MIC	18.00	**9.95**	8.05
AA-2048	KOSS/FORD HEADPHONES 2 FOR 1 DEAL		**39.95**	
AX-3517	6.5" SPEAKER GRILLE W/ SMALL HOLES		**7.95**	
BA-1402	LOUDSPEAKER RECIPES BOOK 1	49.95	**39.95**	10.00
BM-2476	306 CIRCUITS	34.95	**29.95**	5.00
BM-2493	22 PROJECTS USING LM-3909	6.50	**4.95**	1.55
BB-7010	30 SIMPLE IC TERM BLOCK PROJECTS	19.95	**15.95**	4.00
BB-7054	INTRO TO LEGO MINDSTORMS	39.95	**34.95**	5.00
CW-2107	6.5" CARBON FIBRE WOOFER SHIELDED	78.95	**68.95**	10.00
CS-2292	6.5" LOW COST CAR SPLITS	79.95	**69.95**	10.00
CS-2586	JC25 CABINETS - BLACK PAIR	219.00	**199.00**	20.00
CX-2690	FLARED PORT 62MM ID 112MM LONG	4.95	**3.95**	1.00
CF-2782	8" DUSTCAP REPAIR KIT	6.95	**4.95**	2.00
CF-2783	10" DUSTCAP REPAIR KIT	9.95	**7.95**	2.00
CF-2784	12" DUSTCAP REPAIR KIT	12.95	**9.95**	3.00
CW-2845	LARGE SPEAKER STANDS	109.95	**89.95**	20.00
HP-0102	SCREW ASSORTMENT KIT	12.95	**9.95**	3.00
HP-0204	NUT 2.5MM STEEL PK 20	3.10	**2.10**	1.00
HP-0710	4-7MM W'PROOF GROMMET PK 2	5.25	**4.25**	1.00
HP-0712	6-10MM W'PROOF GROMMET PK 2	5.25	**4.25**	1.00
HP-0804	PUSH ON RUBBER FEET 20X10.5 PK 4	2.00	**1.40**	0.60
HP-0808	PUSH ON RUBBER FEET 30X13 PK 4	2.20	**1.50**	0.70
HP-0810	PUSH ON RUBBER FEET 30X13 PK100	23.50	**20.00**	3.50
HP-0812	PUSH ON RUBBER FEET 20.2X8 PK4	2.35	**1.60**	0.75
HP-0814	PUSH ON RUBBER FEET 20.2X8 PK100	21.25	**18.00**	3.25
HM-3005	30 AMP CAR BATTERY CLIP RED	1.00	**0.80**	0.20
HM-3006	30 AMP CAR BATTERY CLIP BLK	2.75	**2.00**	0.75
HM-3218	4 WAY LAUNCHER SOCKET CRIMP	0.25	**0.20**	0.05
HM-3220	8 WAY LAUNCHER SOCKET CRIMP	0.35	**0.25**	0.10
HB-6324	TACKLE BOX WITH LIGHT + TORCH	17.95	**12.95**	5.00
HB-6358	DELUXE ALUM LAPTOT ATTACHE CASE	169.00	**149.00**	20.00
HB-6377	LAPTOP ATTACHE CASE MED BLUE	39.95	**34.95**	5.00
HB-6378	LAPTOP ATTACHE CASE LGE BLUE	49.95	**39.95**	10.00
HK-7722	ALPS SLIDER POT KNOB	0.35	**0.25**	0.10
KK-2050	MULTITURN CERMET TRIMPOT CAB KIT	119.00	**99.00**	20.00
KK-2055	I.C. SOCKET LOW PROF & MACH CAB KIT	79.00	**59.00**	20.00

Cat. No.	Product Description	WAS $	NOW $	SAVE $
KD-6082	PC CONTROLLED LCD THERMOSTAT KIT	69.95	**64.95**	5.00
KJ-7028	SOUND SYNTH LAB W VOICE RECORDER	59.95	**49.95**	10.00
KJ-7040	EXPERIMENTAL BELL KIT	19.95	**16.95**	3.00
KJ-7042	EXPERIMENTAL MOTOR KIT	19.95	**16.95**	3.00
KJ-7044	EXPERIMENTAL GENERATOR KIT	19.95	**16.95**	3.00
KJ-7048	AM/FM RADIO KIT	29.95	**24.95**	5.00
KJ-8720	RUNNING L.E.D. DISPLAY KIT	179.00	**169.00**	10.00
LT-3121	RABBIT EARS SQUARE BASE	11.95	**8.95**	3.00
LA-5080	DOOR STRIKE RELEASE 24VOLT	49.95	**39.95**	10.00
LA-5153	REMOTE FOR LA5152 ALARM	14.95	**9.95**	5.00
LA-5310	SIREN/STROBE 12VDC RED	19.95	**12.95**	7.00
LA-5350	DIGITAL ACCESS 3 OUTPUT KEYPAD	129.50	**109.50**	20.00
LA-5354	REMOTE ALARM KEYSWITCH	39.95	**34.95**	5.00
MP-3013	800MA REGULATED CIG DC-DC CONV	22.50	**19.95**	2.55
MS-4025	PHONE & MAINS SURGE PROTECTOR	24.95	**19.95**	5.00
NA-1027	WATER DISPLACER	8.95	**6.95**	2.00
PS-0653	WALL PLATE 1 BNC SOCKET	6.70	**4.00**	2.70
PA-0903	D9 FEMALE TO D15 HD MALE	6.70	**5.00**	1.70
PA-0923	USB A FEM TO B MALE GENDER CHNGR	11.25	**6.95**	4.30
PL-0943	20MT ETHERNET CABLE	27.95	**17.95**	10.00
PL-0945	INTERNAL SCSI 3WAY FLAT CABLE	7.80	**5.50**	2.30
PP-1026	WALL PLATE 3 PIN MALE CANNON	6.70	**5.00**	1.70
PP-1028	WALL PLATE 3 PIN MALE CANNON DBL	10.95	**8.45**	2.50
PM-1446	RJ 45 BOOTS BLACK PK50	13.50	**9.50**	4.00
PP-2004	ILLUMINATED CIGARETTE LIGHTER PLUG	2.95	**2.40**	0.55
PS-4112	POWER LEAD 3P 240VAC@10A 2M BARG	2.00	**1.50**	0.50
QM-1050	DIG/ANALOGUE DATA HOLD 3.5 DIG DMM	87.95	**72.95**	15.00
QM-1300	30 RAMGE DMM LARGE LCD DISP	55.00	**45.00**	10.00
QM-1301	30 RANGE DMM BIG LCD DIGITECH	69.95	**54.95**	15.00
QM-1321	DMM TEMP/CAP/FREQ/D.HOLD/B.LIGHT	85.00	**65.00**	20.00
QM-1532	DMM AUTORANGE W/O TEMP	79.95	**59.95**	20.00
QM-1540	DMM AUTORANGE DBLE INS REL	89.95	**69.95**	20.00
QM-1585	DIGITAL LUXMETER	99.00	**69.00**	30.00
QM-1620	ULTRASONIC TAPE MEASURE	69.95	**49.95**	20.00
QT-2210	LOGIC PROBE 20MHZ	37.95	**32.95**	5.00
QP-2250	MULTI DMM TESTPROBE W LIGHT, HOT	9.95	**$6.95**	3.00
QC-3200	4 CH PAN/TILT CONTROLLER FOR QC3210/15	249.00	**199.00**	50.00
QC-3462	CCD B+W BOARD CAM WITH AUDIO	115.00	**79.00**	36.00
QT-7198	ADVANCED PROGRAMMABLE THERMOSTAT	79.95	**59.95**	20.00
QM-7248	MINI SCALE 100GRAMS (0.1G 0-50G)	99.00	**149.00**	50.00
QM-7270	JUMBO DESK CALCULATOR	17.95	**13.95**	4.00
RT-4035	2K OHM VERT.MIN. T-POT 10MM	0.40	**0.20**	0.20

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SAVE $$$ ON OUR DISCONTINUED PRODUCT SELLOUT

OVERNIGHT DELIVERY AVAILABLE

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AEI Alarm Kit

Kit Includes:
AEI 6 sector panel with keypad
3 x Pulse analogue PIR's
1 x Mains power supply
1 x 1.3Ah back up battery
1 x Strobe warning light
1 x Siren cover/ tamper switch
1 x Siren horn
1 x Internal siren
3 x Reed/magnet switches
100 metres 4 core alarm cable
2 x Alarm stickers

Was $489 **Now $439** Save $50
Cat. LA-5365

MELCOM 8 Sector Alarm Budget Kit

Kit Includes:
1 x 8 sector MELCOM keypad alarm
2 x Micron pulse count PIRs
1 x Mains power supply
1 x 1.3Ah backup battery
2 x Reed / magnet switches
1 x Siren horn
60 Metres of 6 core alarm cable
2 x Alarm stickers

Was $329 **Now $299** Save $30
Cat. LA-5445

MELCOM 8 Sector Alarm Deluxe Kit

Kit Includes:
1 x 8 sector MELCOM keypad alarm
3 x Micron pulse count PIRs
1 x Mains power supply
1 x 1.3Ah backup battery
1 x Strobe warning light
1 x Siren cover
1 x Siren horn
1 x Internal siren
3 x Reed / magnet switches
100 Metres of 6 core alarm cable
2 x Alarm stickers

Was $429 **Now $399** Save $30
Cat. LA-5447

Cat. No	Product Description	WAS $	NOW $	SAVE $
RT-4042	50K OHM VERT.MIN. T-POT 10MM	0.40	**0.20**	0.20
RT-4043	100K OHM VERT.MIN. T-POT 10MM	0.40	**0.20**	0.20
RT-4048	2M OHM VERT.MIN. T-POT 10MM	0.40	**0.20**	0.20
RG-5183	8.0UF 100V 8000NF GREENCAP	6.95	**3.95**	3.00
RC-5347	8200PF CERAMIC 50V CAP PK 2	0.28	**0.18**	0.10
SF-1930	20A MAXI BLADE FUSE YELLOW	1.95	**1.45**	0.50
SF-1934	40A MAXI BLADE FUSE ORANGE	1.95	**1.45**	0.50
SF-1938	60A MAXI BLADE FUSE GREY	1.95	**1.45**	0.50
SZ-2048	GOLD BLADE FUSE HOLDER SCREW TERM	8.95	**5.95**	3.00
SZ-2050	5AG PANEL MTG FUSE HOLDER	5.65	**4.65**	1.00
SB-2408	2/3A 3.6V 1900mAH LITHIUM CELL	14.50	**12.50**	2.00
SB-2428	3.6V 70mAH Ni - MH COMPUTER BATT	12.95	**9.95**	3.00
SB-2443	AA Ni- MH 1500mAH BATTERY S/TAGS	4.55	**3.00**	1.55
SB-2474	3.6V 280mAH NICAD PACK STACK	14.50	**9.95**	4.55
SB-2475	4.8V 250mAH NICAD PACK	16.75	**12.95**	3.80
SB-2546	HEARING AID BATTERY PK 6	11.83	**9.85**	1.98
SL-2804	44MM RACK MOUNTED LAMP W/DIMMER	55.95	**45.95**	10.00
SL-2824	YELLOW CHASING ROPELIGHT	59.95	**39.95**	20.00
SL-2900	SANTA MOTIF OUTDOOR LIGHT 141X184	449.00	**399.00**	50.00
SL-2948	MILLENIUM LIGHT CHASER SET	129.00	**99.00**	30.00
SL-2987	ROTATING POLICE LIGHT BLUE 240V	49.95	**34.95**	15.00
ST-3014	FLOURO TUBE ROUND 4PIN SUIT MAG LAMP	13.95	**9.95**	4.00
ST-3030	RECHARGABLE SPOTLIGHT 6V 4AH + ADAPT	45.95	**35.95**	10.00
ST-3039	SUPERBRIGHT RED LED SAFETY LIGHT	28.00	**22.00**	6.00
ST-3045	MINI SAFETY LIGHT KEYRING	6.80	**3.95**	2.85
SY-4026	24V SPST SLIM RELAY 3A @ 250VAC	3.50	**2.50**	1.00

Cat. No	Product Description	WAS $	NOW $	SAVE $
SY-4055	110VDV SPST RELAY 3A @ 250VAC	3.95	**2.00**	1.95
TS-1294	HOT BLOW TIP+CATALYST FOR TS1290	17.95	**12.00**	5.95
TS-1675	DURATECH MICRO GAS TORCH	39.95	**32.95**	7.00
TH-1790	FLOOR MAT GROUDING CORD - GRN	11.25	**7.00**	4.25
TH-1897	ELECTRICIANS LONG NOSE PLIERS	16.95	**11.95**	5.00
TH-1964	SCREWDRIVER CARRY RACK	7.95	**5.95**	2.00
TD-2047	COMPUTOR TOOL KIT	29.95	**23.95**	6.00
TD-2056	12PCS ELECTRICAL TOOL KIT IN CASE	54.95	**39.95**	15.00
WA-1084	3RCA PLUG TO 3RCA PIGGYBACK PLUG	7.50	**5.00**	2.50
WS-6004	HEADER JUMPER LEADS PK10 COLOUR	6.95	**5.00**	1.95
WQ-728610	MT DC PLUG EXT LEAD 2.1 X 5.5mm	13.95	**10.00**	3.95
WV-7424	N64 CONTROLLER EXTENSION LEAD 1.8MT	16.75	**6.75**	10.00
XC-0111	CLOCK 8" 24 HOUR	19.95	**10.00**	9.95
XC-0125	LCD PROJECT COUNTDOWN TIMER	24.95	**9.95**	15.00
XC-0228	SUPER GLOW TRAVEL ALARM CLOCK	23.95	**17.95**	6.00
XC-4640	14" MONITOR SHELF	29.95	**24.95**	5.00
XC-4642	15"-17" MONITOR SHELF	34.95	**29.95**	5.00
XC-4712	80 MIN CD-R 25PK SILVER PYROD	23.95	**19.95**	4.00
XC-4753	SONY 3.5" HD IBM FLOPPY DISKS	10.49	**8.49**	2.00
XC-4790	3.5" FLOPPY DRIVE HEAD CLEANER	4.95	**3.00**	1.95
XC-4836	USB TO DB25M RS232 CONVERTER	84.95	**74.95**	10.00
XC-5052	CELERON CPU COOLER 3 WIRE	18.95	**13.95**	5.00
XL-5090	NOTEBOOK SECURITY LOCK CABLE D9 1.7M	39.95	**29.95**	10.00
YT-6000	TALKING CALLER ID	39.95	**19.95**	20.00
ZD-1780	WHITE 6000MCD 5MM LED	7.80	**4.95**	2.85
ZM-9014	SOLAR CELL 6VOLT 500mA	89.95	**74.95**	15.00

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Soldering Gun W/ Pilot Light

NEW

Soldering guns are ideal for field technicians working on TV chassis', for example, or where a soldering task requires more heat than a 60W iron can provide. The tip can reach full temperature in seconds - great for fast jobs - with a maximum of 12 seconds on and a minimum of 48 seconds off. Trigger controlled, the gun is made from lightweight, impact resistant plastic and also features a light. 240V mains powered.
Cat. TS-1425
Spare tip available TS-1426 $4.95

$29.95

Vacuum Bench Vice with 75mm Jaw

NEW

This is a robust, hardwearing bench vice that features a powerful suction base for portability. The jaws have removable soft rubber jaw covers with 'V' grooves for holding cylindrical and irregular shapes. A multi-positional ball swivel allows the jaws' working position to be varied through a full 360° axis. Cat. TH-1766

$57.95

Hot Glue Gun 40 Watt 240V

A handy tool to have around the house, easy to use trigger control, works on most surfaces for low stress fixing.
Cat. TH-1992

Buy this month and receive 2 free 6 packs of glue (TH-1995) worth $5.90

$19.95

ABS Plastic Tool Attache Case

NEW

Stylish in design, and built to last. This new style tool case is made from extruded aluminium & strong and durable ABS panels, that wont show its age like aluminium ones do. The inside features a removable tool pallet and adjustable dividers for up to 6 compartments.
Size: 450(W)x 330(D)x 150(H)mm.
Cat. HB-6365

$59.95

ABS Case with Foam Insert

NEW

This lightweight case is near identical to the one (above) but instead features foam blocks that you remove to form the shape of your equipment for a snug fit. Perfect for video equipment, test equipment or even wine bottles & glasses.
Cat. HB-6364

Size: 458(W) x 335(D) x 152(H)mm

$69.95

Lead Free Solder

NEW

This 5 core resin flux solder uses no lead and is comprised of tin and antimony. The melting range is 236° -243° Celcius and is supplied in a 20 gram pack.
Cat. NS-3080

$2.50

Mini Gas Soldering Iron

NEW

A lightweight, portable soldering iron for small jobs in the car or boat. Clear fuel tank tells you when to fill up and with an overall length of 170mm its small enough for your glovebox or toolcase.
Use Jaycar Gas Cat NA-1020 $5.95.
Cat. TS-1110

$29.95

Keyring Screwdriver Set

NEW

Need a screwdriver but don't have a tool box handy, now you will always be prepared, with this screwdriver keyring set, consisting of a 5mm slotted and a #2 Phillips head.
Cat. TD-2012

$2.95

BIG SAVINGS ON SLA BATTERIES

6V 4AH SLA Battery
Cat. SB-2496
WAS $22.50 SAVE $8 **NOW $14.50**

6V 12AH SLA Battery
Cat. SB-2497
WAS $36.95 SAVE $10 **NOW $26.95**

12V 1.2AH SLA Battery
Cat. SB-2480
WAS $24.95 SAVE $6 **NOW $18.95**

12V 4.2AH SLA Battery
Cat. SB-2484
WAS $39.50 SAVE $10 **NOW $29.50**

12V 7.2AH SLA Battery
Cat. SB-2486
WAS $39.95 SAVE $10 **NOW $29.95**

12V 18AH SLA Battery
Cat. SB-2490
WAS $88.95 SAVE $19 **NOW $69.95**

8 Way Colour DIL Switches

NEW

Quality English manufactured DIL switches all have different coloured actuators and flux wash stickers.
Cat. SM-1025

$2.25

OVERNIGHT DELIVERY AVAILABLE

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Sim Card Reader

NEW

Here is an easy way storing, managing, sharing and printing the data stored on your mobile phones SIM card. You can edit / back up your phone book and print out SMS text messages. Connects to your computer via the 9 pin serial port, accepts full size SIM card and a small SIM card adapter is included.
Cat. XC-5100

$39.95

Keyboard, Mouse, Monitor Lead for PS/2 Switchbox

NEW

Combined lead gives you a neat connection between your computer and a PS/2 switchbox. 1mt long, colour coded connectors and ferrite suppression on the monitor lead.
Cat. WC-7570

$22.95

Video Intercom System

This device allows you to talk to and see who is at the door before you open it, and with an optional door latch solenoid you can remotely "buzz" people in. Remote Door Solenoid available
Cat. LA-5078 $49.95.
Cat. QC-3412
WAS $299.50

$279.50

SAVE $20

Digital Kitchen Scales 2KG

Ideal for the kitchen or mailroom. These scales will measure from 1 gram to 2 kilos. Includes tare function and also reads in ounces. 4AA batteries included. Resolution 1gram/0.1ounce.
Cat. QM-7245
WAS $59.95

SAVE $10

$49.95

Pulse Pir-Analogue Design

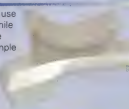
This PIR uses analogue technology to counter false alarms due to things such as power fluctuations, stray UV or RF signals. The use of surface mount technology also makes this unit smaller than most other PIR's.
Cat. LA-5020
WAS $39.95

SAVE $10

NOW $29.95

Tele Mate Shoulder Rest

Allows you to use both hands while you are on the telephone, simple idea that works well.
Cat. YT-6025



WAS $11.95
Limited stocks.

SAVE $2

$9.95

5 Port 10/100 N-Way Switch

This high performance, 5 port, 10/100 N-Way switch manages data packets on the network to improve the overall transmission speed and network efficiency. Comprehensive front panel indicators show connection status and activity. 9 VAC power pack included. Also available in 8 port.
Buffer Memory: 128KB
Transmission Speed: 10/100Mbps
Cat. YN-8082
WAS $179.95

SAVE $20

NOW $159.95

8 PORT 10/100 N-WAY SWITCH

NEW

Buffer Memory: 256KB
Transmission Speed: 10/100Mbps
Cat. YN-8084
WAS $219.95

SAVE $30

NOW $189.95

Compact Laminator

Protect precious photos and business cards by laminating them in plastic. This unit will accept cards or photos up to 100 x 150mm (6"x4") and 0.3mm thick. Operates on 240Volts.
Cat. XL-2502
WAS $59.95
Laminating Sleeves Available

SAVE $10

$49.95

Business Cards: 97x57mm
Cat. XL-2504

$7.50

Photos: 156x112mm
Cat. XL-2505

$7.95

Laser 700MB 80Min CD-RW

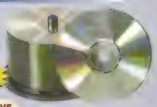
NEW

Up to 10 speed re-writable.
Cat. XC-4723

$3.95

Laser 80 Min - 700Mb Gold CDR - Tub of 50

Up to 36X speed.
New low price
Cat. XC-4718
WAS $23.95

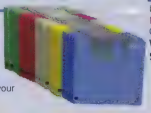


$17.95

SAVE $6

3.5" Coloured Floppy Disks

Pack of 25 3.5" HD IBM formatted disks in five fun colours, also useful for colour coding your files.
Cat. XC-4742
WAS $13.95



SAVE $3.45

NOW $10.50

Laser 80 Min - 700Mb Gold CDR - pkt of 20

Up to 36X speed.
New low price
Cat. XC-4710
WAS $19.95

$17.95

SAVE $2

Jaycar ELECTRONICS No 1 For Kits

My First Clock

NEW

This clock is designed to stimulate a childs curiosity and their desire to learn and explore.
By combining the parts you create a fully operational clock, installing the colour coded gears into the transparent casing, children can then see the workings of the clock.
For ages 6 and above.
Cat. XC-0113

$24.95

Kit Headphone Amplifier

Ref: SC May 2002
Use this effective little kit as a general purpose headphone amplifier for any line level signal (eg from CD/DVD). +/-15V DC required.
Kit includes PCB plus all electronic components.
Cat. KC-5335

$19.95

NEW

Multi Mode Timer

NEW

A single-sided PCB using a micro-controller to replace traditional cmos ICs.
Has seven timing modes.
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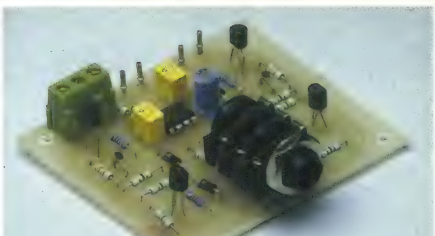
In March, we told you how we rescued an old turntable and fitted it with a self-powered RIAA preamplifier so it could be used with modern hifi amplifiers. Here's the promised second part of the story: a matching headphone amplifier so you can enjoy the fantastic black plastic in perfect peace and privacy!



A Simple Headphone Amp For Your RIAA Turntable (or anything else!)

By Ross Tester

To briefly recap, the RIAA preamplifier was presented for those who have a modern sound system. More often than not these days, modern systems don't include a "phono" input, which precludes the use of a turntable to listen to records (as distinct from CDs!).

The preamp not only provides the necessary gain for a magnetic cartridge, it also "tailors" the signal to the RIAA standard, allowing you to plug into any "aux" or line-level input.

The idea of our preamplifier was to make it fully self-contained, with its own 240V to ±15V DC supply built on the PC board. To be honest, this didn't work out quite as well as we had hoped due to noise being induced into the preamp from the mains supply. But we were one step ahead on this one (just in case!), making the two sections of the PC board separable.

The 240V to power the whole shebang is, of course, already available from the turntable supply. The ±15V, 10VA DC supply was in fact a bit of overkill, being capable of much more than demanded by the preamp. But then, we always had this little project in the back of our minds.

About the only change we'd make from the project published in March would be the use of larger U-shaped heatsinks to cope with increased current (there's tonnes of room on the PC board for them) and the use of PC-board mounting screw-in terminal blocks on at least the power supply board (where there is plenty of room) and possibly the RIAA board – where space might be a tad tight.

Of course, there's nothing to stop you using this project as a general-purpose headphone amplifier, as long as it is fed with "line level" signals – such as the output of a CD/DVD player, tuner, etc.

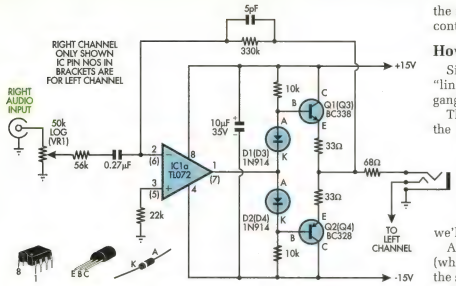
The amplifier circuit

This design is a tried-and-true circuit we have used before. It's rather similar (or at least one channel of it is!) to the one John Clarke used in the mono headphone monitor amplifier in the 8-channel Mixer (described in November and December 1996). We've made just a few changes which we will go into shortly.

All components except a stereo

Performance of Prototype

Output level	90mW (max) into 8Ω headphones
Frequency response	0.5dB down at 30Hz and 20kHz (see Fig.2)
Input sensitivity	0.83V RMS for full power
Harmonic distortion	see Fig.3 & Fig.4
Signal-to-noise ratio	-95dB unweighted (20Hz to 20kHz) with respect to 500mV input signal
Separation between channels	-50dB between 20Hz and 10kHz



SC HEADPHONE AMPLIFIER

Fig.1: each channel of the headphone amplifier uses an op amp driving a complementary pair of transistors which are within the overall negative feedback loop.

(dual ganged) volume control pot mount on a single PC board measuring 65 x 65mm.

The biggest change from the earlier circuit was to duplicate it for stereo. Rather than use two TL071 op amps (one for each channel) we used a TL072, which is effectively two TL071s in the one 8-pin DIL package. The other changes involve the components in the input and feedback circuits – these have been adjusted to make them optimum for the RIAA preamp output. That's not to say it won't work with other audio sources – it should be pretty-well "universal."

A DC blocking capacitor has also been included in series with both inputs. This is not to prevent any DC present in the preamplifier output from reaching the op amp inputs; rather it is to prevent any DC offset voltage at the op amp inputs (albeit tiny) from being impressed back on the potentiometer.

DC on pots is a no-no: most "noisy pots" that you come across are not the result of mechanical wear and tear but the result of DC flowing in them and to the contact point of the wiper.

How it works

Signal from the RIAA preamp (or other "line level" audio source) is applied to the ganged pots, VR1a and VR1b.

The pot simply forms a voltage divider across the preamp output, presenting the op amp input with a level of signal dependent on the pot setting. At minimum setting, very little (if any) signal gets through; at maximum most gets through. Presto: a level or volume control.

As both stereo channels are identical we'll just look at one (the left) channel.

After passing through a 56kΩ resistor (which basically sets the input impedance), the signal is applied to the inverting input of one of the TL072s twin op amps.

Normally, the feedback loop for the op amp would go from the output back to the input – but in this circuit, transistors Q1 and Q2 are included in the loop. This helps minimise harmonic distortion.

The transistors themselves boost the output current capability of the op amp. To minimise crossover distortion, the transistors are slightly forward-biased by D1 and D2 between their bases.

The 33Ω emitter resistors on each transistor maintain the bias stability. They, along with the 68Ω resistor between their junction and the headphones, limit the output current to less than 150mA under catastrophic failure conditions, protecting the headphones from damage.

The feedback loop previously mentioned consists of a 5pF capacitor in parallel with a 330kΩ resistor. This limits the response to about 50kHz and sets the overall gain of the amplifier (op amp plus output pair) to about six (330kΩ/56kΩ).

Construction

Start by checking your PC board for any defects, then mount and solder components in the usual way: lowest

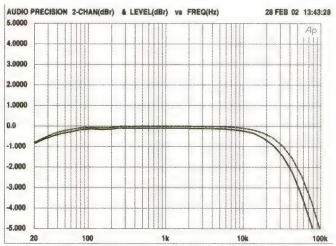


Fig.2: the frequency response of both channels with an input signal of 250mV RMS. The minor differences between channels is probably due to transistor tolerances.

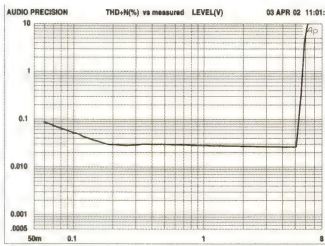
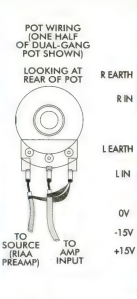
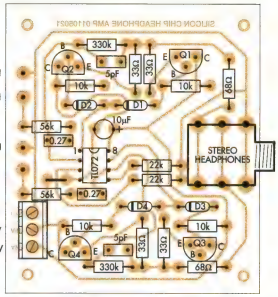


Fig.3: total harmonic distortion (THD) versus frequency with both channels driven with an input signal of 250mV RMS.





Compare the same-size photo and the component overlay (Fig.5) when assembling the PC board. We used 1A diodes in our prototype but ordinary silicon signal diodes are cheaper!

profile (resistors) first, the link (using an offcut from a resistor), then the four small capacitors, the electrolytic (watch the polarity) and finally the semiconductors: diodes, transistors and the IC. Again, watch both the placement and the polarity of the semiconductors.

The headphone socket mounts on the board – provision is made for sockets with pins either side. The power supply is connected via an on-board screw terminal block while signal is connected via four PC stakes.

Checking it out

Check your component placement, polarity and soldering before proceeding. If you're happy with it after a thorough examination, connect the +15V, 0V and –15V from the RIAA preamp supply to this board. Note that the order of the terminals are not the same on both boards: you have been warned!

With no headphones nor any inputs connected, turn the power on. Absolutely nothing should happen (at least as far as visual observation is concerned!).

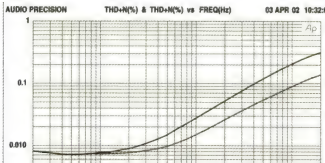


Fig.4: total harmonic distortion (THD) versus output level; measured at the junction of 33Ω emitter resistors when driving 8Ω headphones.

Check that you have +15V and –15V on the board and (respectively) on pin 8 and pin 4 of IC1 and (again respectively) on the collectors of Q1 and Q2. All of these voltages, by the way, are measured with respect to 0V.

Check that you have 0V (or within a couple of millivolts of 0V) on pins 2, 3, 5 and 6 of the IC. You should also have 0V (or very close to it) on pins 1 and 7 (the outputs). Now check the voltages across the diodes and between base and emitter of the four transistors. In every case it should be around 0.6V, give or take. Obviously, in half the cases the polarity should be reversed compared to the other half.

Parts List – Headphone Amp

1 PC board, 65 x 65mm, coded 01105021
1 PC mount stereo headphone socket
1 PC mount 3-way terminal block
4 PC stakes
4 mounting screws (as required)
Suitable lengths red, black and white hookup wire

Semiconductors
1 TL072 dual op amp (IC1)
2 BC338 NPN transistors (Q1, Q3)
2 BC328 PNP transistors (Q2, Q4)
4 1N914 or similar silicon signal diodes (D1-D4)

Capacitors
1 10µF 35VW PC electrolytic
2 0.27µF MKT polyester (code 274 or 270n)
2 5pF ceramic (code 5 or 5p)

Resistors (0.25W, 5%)
2 330kΩ
2 56kΩ
2 22kΩ
4 10kΩ
2 68Ω
4 33Ω
1 50kΩ dual-gang logarithmic pot (VR1)

Finally, check the voltage between the outputs and 0V – again, it should be pretty close to zero.

If all this passes muster, it's time to plug in a pair of headphones. This done, apply the "blurt" test: touch your finger on the input pins (not the earth pins!). You should hear a healthy "blurt" out of each of the headphones in turn.

If you do, you can reasonably assume the system is working (what you're doing is simply connecting a big source of hum and noise – you!) If you don't get any sound, check that (a) the headphones are turned on or up, if they have any controls; (b) they are plugged into the socket; and (c) you still have power to the board.

There's not much that can be wrong given the tests you have already undertaken but if you have sound in one channel only, it's nice to know there is a "reference" right alongside with which to compare voltages.

The pot

Wire the 50kΩ dual-ganged potentiometer as shown. It's important that the inputs to the amplifier go to the wipers of the pots and that both the earths (preamp and amplifier) connect together at the bottom end.

If when using your amplifier later you find that a lot of hum is generated when you touch the volume control, it might pay you to solder a wire from the pot body (you'll probably need to scrape off some of the passivation to bare metal) to the earth braids.

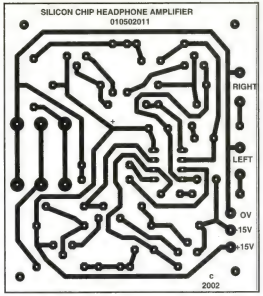


Fig.6: actual size artwork for the PC board.

The pot should be a "logarithmic" type to match the sensitivity characteristics of the human ear. But if all you have (or can get) is a linear pot, you could use it – it won't do any harm but there won't be much control: you'll find that minimum to maximum is squeezed into a tiny section of the pot's travel.

If you are fitting the amplifier board underneath your turntable as with the power supply and preamp, you're going to have to mount the board so the headphone socket emerges from an appropriately-drilled hole in the plinth.

And the volume control will also need a mounting hole drilled – make sure that neither the board nor the pot foul any under-deck mechanical operations.

Just remember to keep the input side of the PC board as far away as possible from the mains transformer and the motor.

Being a line level input, it's not as critical as the RIAA preamp input – but it's better to play safe. **SC**

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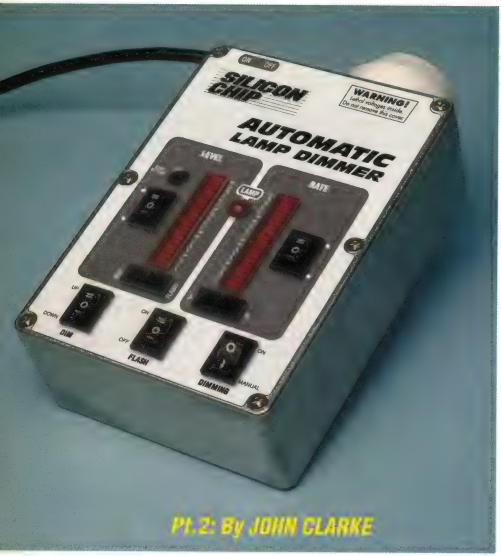
03-01

Automatic single channel light dim

. . . dimming with the power of a PIC

Last month we covered the features and design details of this completely new high power automatic dimmer. It is controlled by a PIC16F84 microcontroller. This month, we conclude with the construction and setting up details and the parts list.



Pt.2: By JOHN CLARKE

The Automatic Light Dimmer is constructed on three PC boards: a Display board coded 10104021 and measuring 89 x 102mm; a Controller board coded 10104022 and measuring 84 x 96mm; and a filter PC board coded 10104023 and measuring 52 x 59mm. These are housed in a diecast box measuring 171 x 121 x 55mm.

You can begin by checking each PC board for any possible problems before they are assembled. In particular, check the pattern against the published artwork for any shorts or breaks in the tracks. Also check the hole sizes drilled to ensure they are suitable for each component. Note that switches S2-S4 and S6-S8 need slotted holes to suit their terminals. The component overlays for all three boards are shown in Fig.4.

Start assembly of the Display PC board by installing the links and diodes. Place the four DIP20 IC sockets in the LED1-40 positions on the PC board. The 10-LED bargraphs need to be inserted with the correct polarity. One of the corners of the LED bargraph package has a small chamfer down one edge. This is the cathode (K) side of bargraph and should be installed in the sockets as indicated on the overlay diagram in Fig.4.

Now install the 8-way right angle pin headers for connectors CONA, B, C and D. Switch S5 can be installed with the "flat" side oriented as shown.

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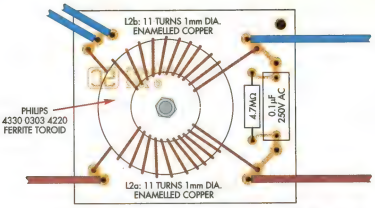


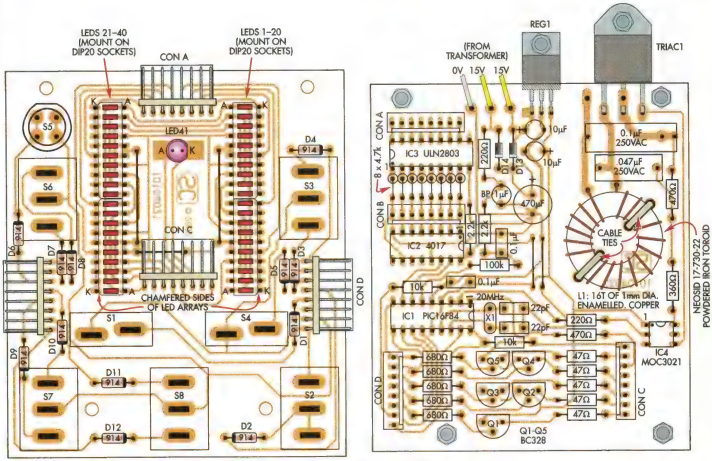


Fig.4: install the parts on the three PC boards as shown here but don't initially mount any of the switches except for S5 (all the other switches are installed on the case lid first – see photo). Note that the two LED bargraph displays on the Display board mount in opposite directions.

Do not install the remaining switches. LED41 is mounted so that the top of its convex lens is 10mm above the top of the LED bargraphs.

Work can now begin on the Controller PC board by installing the links and IC2, IC3 and IC4. IC1 uses a socket. Take care with orienting the ICs and socket and note that IC3 is oriented differently to IC2 and IC1.

When installing the resistors, use the resistor code table as a check when selecting each value. You can also use a multimeter to check each value. The eight 4.7kΩ resistors near IC3 are mounted vertically, ie, end-on.

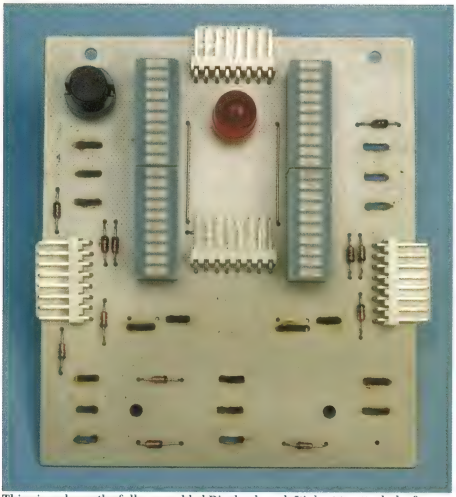
Diodes D13 and D14 can be installed as well as Q1-Q5, taking care with their orientation. Install the 20MHz crystal and the capacitors, taking care to orient the electrolytic capacitors with the correct polarity, as shown. Note that the 1µF bipolar electrolytic can be installed either way.

Install the PC stakes near D13 and D14. Triac1 and REG1 are mounted

WARNING!

Part of the circuitry used in this Automatic Light Dimmer operates at 240VAC (see Figs.1 & 6) and is potentially lethal. Do not touch any part of this circuit while the unit is plugged into the mains and do not operate the circuit outside its earthed metal case.

This project is for experienced constructors only. Do not build it unless you are entirely familiar with mains wiring practices and construction techniques.



This view shows the fully assembled Display board. It's best to attach the four 8-way cables before soldering it to the matching switch hardware mounted on the lid of the case.

under the PC board as shown in Fig.5. The leads are bent at right angles and soldered to the PC board so that the device tabs are 6mm below the bottom of the PC board. Bend the leads over on the top of the PC board to secure them in position before soldering.

Inductor L1 is wound on a Neosid 17-730-22 or Jaycar LO-1244 powdered-iron core using 1mm enamelled copper wire. Wind on 16 turns evenly spaced around the toroid and terminate the leads in the PC boards holes. You will need to scrape away the enamel insulation at each end of the wires and tin them with solder. After soldering the leads to the underside of the PC board, the inductor is secured with two cable ties, each wrapping around the toroid and through holes in the PC board.

Install the four 8-way vertical pin headers as shown.

Making the filter board

The filter PC board is assembled with the 0.1µF 250VAC capacitor soldered in place next to the 4.7MΩ resistor as shown. Inductor L2 has two windings on the one Philips 4330 0303 4220 toroid, using 1mm diameter enamelled copper wire.

Wind on 11 turns evenly spaced on one side of the toroid. The second winding needs to be wound as a mirror image of the first, so be careful with the winding direction. **In other words, if the turns on the first winding go clockwise around the core, the turns on the second winding MUST go anticlockwise. Make sure you get this RIGHT!**

Wind on 11 turns as before. Terminate the windings after scraping and tinning the wire ends. We secured the toroid using two 100mm long cable ties around it and the bottom of the PC board. This holds the toroid in position but also allows some movement, preventing it from shattering if the assembled Automatic Light Dimmer is dropped. Note that this ferrite toroid is rather brittle compared to the more

Table 2: Capacitor Codes

Value	IEC Code	EIA Code
0.1µF	100n	104
.047µF	47n	473
22pF	22p	22

Table 1: Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	4.7MΩ (VR37)	yellow violet green yellow	
1	100kΩ	brown black yellow brown	brown black black orange brown
2	10kΩ	brown black orange brown	brown black black red brown
8	4.7kΩ	yellow violet red brown	yellow violet black brown brown
2	2.2kΩ	red red red brown	red red black brown brown
5	680Ω	blue grey brown brown	blue grey black black brown
2	470Ω	yellow violet brown brown	yellow violet black black brown
1	360Ω	orange blue brown brown	orange blue black black brown
2	220Ω	red red brown brown	red red black black brown
5	47Ω	yellow violet black brown	yellow violet black gold brown

Take care when installing the switches on the lid – they must all be oriented correctly (see text) and some of the switch styles differ (see photo). The two red Perspex windows should be a force fit and can be further secured using a few drops of superglue.

robust powdered iron toroid used for L1.

Making the header cables

There are four cables to be made up using polarised 8-way pin header plugs and 8-way rainbow cable. The "A" and "B" cables are 90mm long, the "C" cable is 180mm long and the "D" cable is 135mm long.

The header cables are made up by first crimping the stripped wire ends into the pins. You may also wish to apply a small amount of solder to each crimp connection to ensure a good contact. The pins then clip into the header plug.

Note, however, that the wiring connections to the polarised header plugs are quite critical. For this reason, be sure to follow the wiring details set out in the next paragraph exactly.

Here's how to wire the four cables: on each of the "A" and "B" cables, connect pin 1 on one header plug to pin 8 on the header plug at the other end, pin 2 to pin 7 and so on. Conversely, for the "C" and "D" cables, connect pin 1 of one header plug to pin 1 of the header plug at the other end, pin 2 to pin 2 and so on.

Mark the ends of each cable with a felt-tipped pen as it is completed, so that you don't get them mixed up later on. That way, when the header sockets are plugged into the pin headers on the Controller PC board, all the connections will be correct, since the headers will only fit one way.

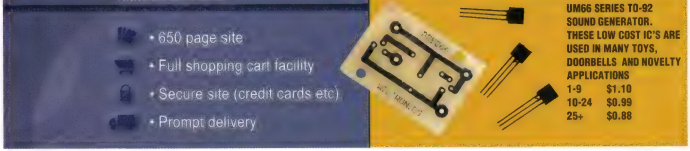
Once the cables have been completed, plug them into the Display PC board, so that it is ready for mounting onto the lid of the case. Take care not to transpose cables "B" and "D" – remember that Fig.4 shows the Display board from the component side.

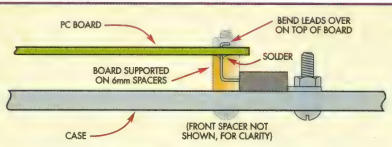
Drilling the case

The lid of the case will require drilling for the switches, LED bargraph displays and the 10mm LED. Use the front panel artwork as a guide to the hole locations and use the display PC board to measure the exact positions. The rectangular holes for the switches and LED bargraphs can be made by drilling out a series of holes within the cutout area and then filing to shape.

Of course, if you buy a kit, all the drilling will have been done for you. We fitted clear red Perspex windows into the LED bargraph cutouts.

When the drilling and filing of the lid is complete, attach the front panel label and cut out the holes with a sharp hobby knife. Insert the switches into the holes allocated, making note of these important points: (1) Switches S1 and S4 need to be oriented so that





REGULATOR AND TRIAC MOUNTING

Fig.5: both REG1 (7805) and the BTA41 insulated tab Triac are bolted to the bottom of the case as shown here. Note that the device tabs must be 6mm below the bottom of the PC board.

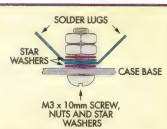


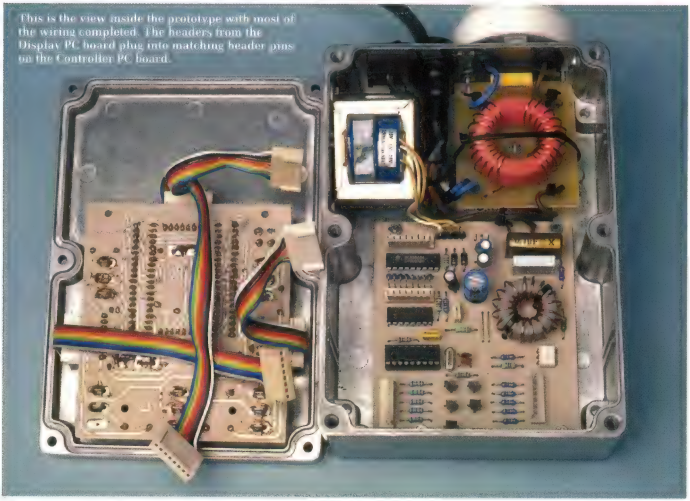
Fig.6: this diagram shows the mounting details for the two earth lugs. The second nut locks the first nut, so that there is no possibility of the earth lug later working its way loose.

the switch contacts are closed when set to the Flash and Rate B positions; (2) Switch S2 is oriented so that its contacts are closed when set to the Manual dimming position; and (3) Switches S3, S6, S7 & S8 can be mounted either way but it is best to orient them all with the same switch legend positions. We elected to place these four switches with the double bar toward the top.

The display PC board is mounted by soldering it directly onto the switch terminals.

Now that the lid is finished, the case itself requires a fair amount of drilling. Mounting holes are required for the controller and filter PC boards, the regulator, Triac, earthing lug and the transformer. As well, one end of the case requires holes for the power switch S9, fuse F1, cord-grip grommet and the surface mount General Purpose Outlet (GPO) mains socket. Two holes are required to mount the socket and three holes are for the grommets that allow the wires to pass through the panel into the GPO terminals.

Transformer T1 is mounted on the side of the case at an angle so that it does not foul the display PC board when the lid is placed on the box. One of the mounting feet needs to be bent up so that it fits against the integral pillar in the case. Use countersunk screws to mount the transformer so



This is the view inside the prototype with most of the wiring completed. The headers from the Display PC board plug into matching header pins on the Controller PC board.

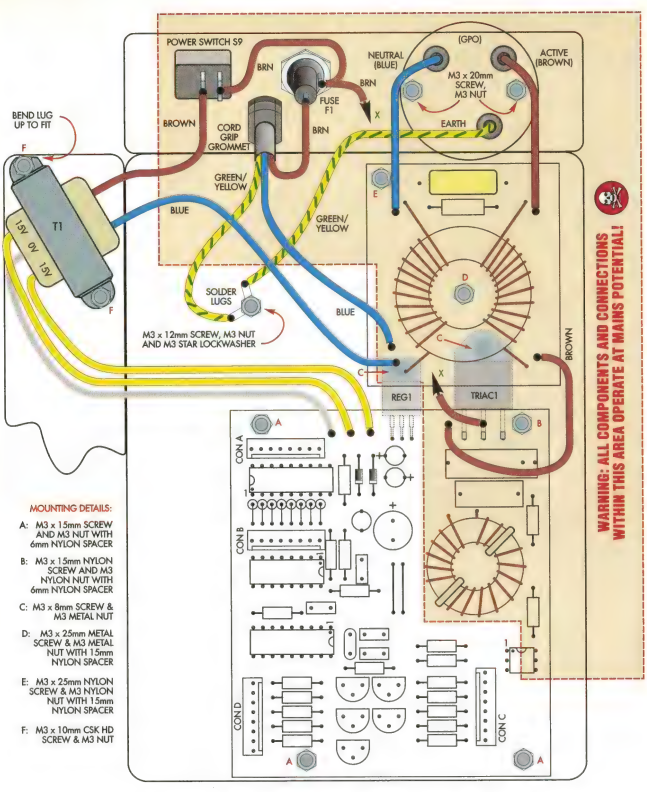


Fig.7: the mains wiring details. Use cable ties to bind the leads and note that inductor L2 (top) is secured with two cable ties that loop under the PC board (see photo). Be sure to use nylon screws, nuts and spacers where specified.

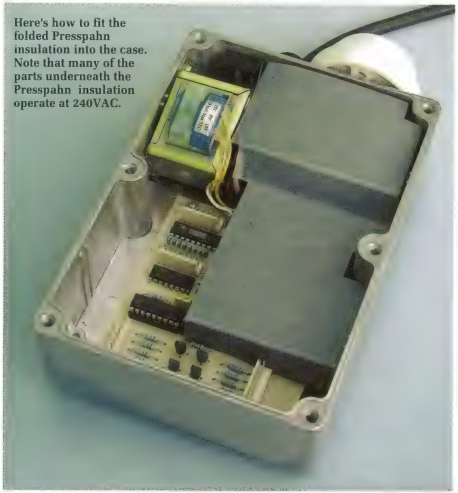
that they are flush with the outside of the box.

Installing the hardware

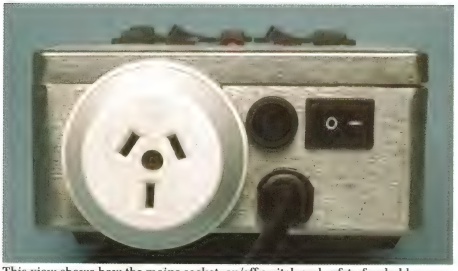
We are now in the final assembly stage where everything is wired together, as shown in Fig.7.

Install the mains cord first. Strip back about 200mm of the outer sheath of the mains cord so that there is sufficient lead length for all the mains wiring. Cut off 50mm and 100mm lengths of the brown Active wire from the mains cord and solder the 50mm length to provide the connection between the filter board and the controller PC board. The 100mm length provides the connection from the fuseholder to the controller board (shown as "X" on Fig.7).

Apply a smear of heatsink compound to the underside of the Triac tab and regulator tab before bolting them down. Note that the specified Triac has an isolated tab which means that the metal flange on the device is not connected to any of the pins. You



Here's how to fit the folded Presspahn insulation into the case. Note that many of the parts underneath the Presspahn insulation operate at 240VAC.



This view shows how the mains socket, on/off switch and safety fuseholder are mounted on one end of the case. Make sure that the mains cord is properly secured using a cordgrip grommet.

can check this by measuring the resistance between the tab and the pins with a multimeter.

If the resistance shows a short circuit then the Triac is not an isolated tab type and should not be used. An open circuit measurement will show if the Triac is the correct isolated tab device.

Mount the controller PC board on 6mm Nylon spacers using 15mm long screws. Note that the screw near Triac1 must be a Nylon screw (see Fig.7). Secure the regulator and Triac to the case with 8mm long screws and nuts.

Fit the mains cord into the hole in the case with a cordgrip grommet. Make sure that this cord cannot be pulled out from the case once secured in place. The green-yellow earth wires are attached to the case using crimp eyelets and a screw, two star washers and two nuts – see Fig.6.

Fit switch S9, fuseholder F1, the GPO socket and its grommets and wire switch S9 and fuseholder F1 as shown. Be sure to sheath the fuseholder terminals, with 10mm diameter heatshrink tubing and the switch terminals with 5mm heatshrink tubing.

Mount the transformer now. Note that the switch terminals will need to be bent over slightly to allow clearance for the transformer.

Connect the wiring to the filter PC board and to the GPO before mounting the filter PC board on 25mm screws and 15mm Nylon spacers. **Note that a Nylon screw and nut is used for the corner mounting position on the filter PC board. Do not use a metal screw in this position otherwise there is a risk of flashover.** This applies to any position where we have specified Nylon screws – see Fig.7.

Connect the transformer secondaries to the Controller PC board as shown. **The mains wiring needs to be tied so that if one wire should come adrift it will still be secured in place with another wire connection. Use cable ties to strap the wires in place on the switch, the back of fuseholder F1 and the wires on the filter PC board.**

Finally, attach four rubber feet to the base of the case.

Presspahn insulation

As shown in the accompanying photo, a folded piece of Presspahn or Elephantide insulation is used to cover the high-voltage section of the circuitry (apart from the mains switch). This serves to isolate the low-voltage cable wiring from those components operating at mains potential when the lid is attached and is important for long-term reliability. Fig.8 shows the cut-out and folding details for the insulation material.

Testing

Check your wiring very carefully, making sure all the wires are connected to the correct positions. Also check that the mains Earth lead is

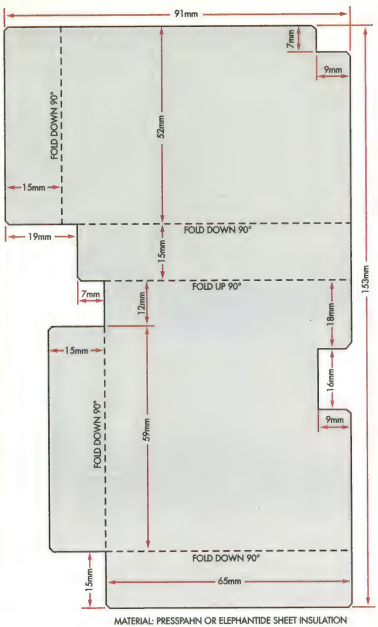


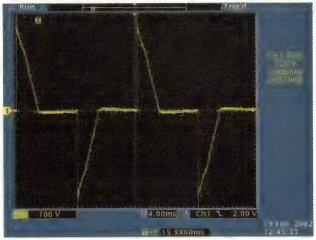
Fig.8: you can use this diagram as a template for marking out and cutting the Presspahn insulation material. Fold the cutout along the dotted lines in the direction indicated.

connected to chassis and that the Earth terminal on the GPO is also connected to chassis. **You can check that there is continuity from the Earth pin on the mains plug to chassis and to the Earth connection on the GPO using a multimeter.**

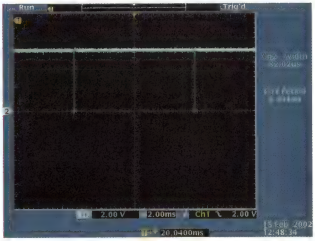
The Automatic Dimmer is best initially tested with the lid secured in place with its mounting screws. Apply power and check that the display LEDs light. If the LEDs do not light, switch off power immediately and disconnect the power plug. Check that the fuse is intact and that the switch was turned on.

PLEASE NOTE!

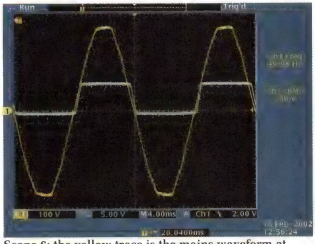
The scope waveforms in this article are shown to explain the operation of the circuit. DO NOT try to reproduce these waveforms yourself – it is much too dangerous.



Scope 4: this shows the lamp voltage when the Triac is fired at the peak of the mains waveform. The resulting RMS voltage is about half the 250V or 126V as measured by the oscilloscope.



Scope 5: this is the gate drive pulse as seen at pins 2 and 3 of IC1. This pulse drives the optocoupled Triac driver IC4 via a 220Ω resistor. The gate pulse width is 82µs.



Scope 6: the yellow trace is the mains waveform at 50Hz and 250VAC. The blue trace is the signal applied to pin 6 of IC1 to detect the zero voltage crossing point of the mains waveform. This voltage is clipped at +5.6V and 0.6V below ground via the internal clamping diodes of IC1.

Parts List

1 display PC board, code 10104021, 89 x 102mm
1 controller PC board, code 10104022, 84 x 96mm
1 filter PC board, code 10104023, 52 x 59mm
1 front panel label, 116 x 168mm
1 diecast aluminium box, 171 x 121 x 55mm
2 10mm x 51.5 x 2mm clear red Perspex or Acrylic
1 sheet of Elephantide or Press-pahn insulation, 100 x 160mm
1 30V centre-tapped 5VA mains transformer with internal thermal fuse (T1) (Jaycar MM-2007 or equivalent)
1 iron powdered toroid, 25 x 13 x 10mm approx, AL 77 (L1) (Neosid 17-730-22 or Jaycar LO-1244)
1 Ferrite toroid, 37 x 22 x 16mm approx, AL 7390 (L2) (Philips 4330 0303 4220 or Jaycar LO-1238)
2 SPST ultra-mini rocker switch (S1,S4) (Jaycar SK-0975, Altronics S-3202 or equiv.)
4 SPDT centre off spring return rocker switch (S3,S6,S7,S8) (Jaycar SK-0987 or equiv.)
2 SPST mini rocker switch (S2, S9) (Jaycar SK-0984 or equiv.)
1 snap action keyboard switch (S5) (Jaycar SP-0721, Altronics S-1096 or equiv.)
1 20MHz parallel resonant crystal (X1)
1 10A surface mount mains outlet (HPM Cat. NO.35)
1 2AG panel-mount safety fuse holder
1 10A 2AG fuse
1 10A mains plug and lead
1 cord grip grommet to suit mains lead
4 DIP20 IC sockets (for LEDs1-40)
1 DIP18 IC socket (for IC1)
3 9mm rubber grommets
8 8-way 0.1-inch polarised header plugs (Jaycar Cat. HM-3408 or equivalent)
4 8-way 0.1-inch polarised pin headers (Jaycar Cat. HM-3418 or equivalent)
4 8-way 0.1-inch polarised right-angle pin headers (Jaycar Cat. HM-3428 or equivalent)
1 550mm length of 8-way rainbow cable
2 M3 x 10mm countersunk screws
2 M3 x 8mm pan head screws
1 M3 x 12mm pan head screw
2 M3 x 20mm pan head screws
1 M3 x 15mm Nylon screw
3 M3 x 15mm metal screws
1 M3 x 25mm Nylon screw
1 M3 x 25mm metal screw
2 15mm M3 tapped plastic standoffs
4 6mm M3 tapped plastic standoffs
12 M3 nuts
2 M3 Nylon nuts
2 M3 star washers
2 crimp eyelets
4 rubber feet
1 45mm length of 10mm diameter heatshrink tubing
1 20mm length of 4mm diameter heatshrink tubing
10 100mm long cable ties
1 2.3m length of 1mm diameter enamelled copper wire
1 150mm length of 0.8mm tinned copper wire
3 PC stakes

Semiconductors

1 PIC16F84A-20P microcontroller programmed with autodim.hex (IC1)
1 4017 decade counter (IC2)
1 ULN2803 8-way Darlington driver (IC3)
1 MOC3021 Triac driver (IC4)
1 7805 3-terminal regulator (REG1)
1 BTA41.600B 40A 600V insulated tab Triac (TRIAC1)
5 BC328 PNP transistors (Q1-Q5)
12 1N914, 1N4148 diodes (D1-D12)
2 1N4004 diodes (D13,D14)
4 10-red LED bargraph displays (LED1-LED40)
1 10mm red LED (LED41)

Capacitors

1 470µF 25VW PC electrolytic
2 10µF 25VW PC electrolytic
1 1µF bipolar electrolytic
2 0.1µF 250VAC X2 class
2 0.1µF MKT polyester
1 .047µF 250VAC X2 class
2 22pF NP0 ceramic

Resistors (0.25W 1%)

1 4.7MΩ Philips VR37 high-voltage type (DO NOT substitute)
1 100kΩ
2 10kΩ
8 4.7kΩ
2 2.2kΩ
5 680Ω
2 470Ω
1 360Ω
2 220Ω
5 47Ω

Check that the LED bargraphs have been installed correctly. Also you may need to check the supply voltages on IC1 and IC2 for 5V. There should be 5V between pins 5 and 14 on IC1 and between pins 8 and 16 on IC2. **Be careful when checking voltages since the righthand side of the PC board has mains voltages on it. This includes the MOC3021 (IC4), L1 and the adjacent 360Ω and 470Ω resistors and the Triac leads.**

If the displays are operating, you should be able to set the dim and flash levels and the rates using the up and down set level switches. Also the LED lamp indicator should light according to the dimming level. Check operation of the autodim function and the flash.

You can set the filament preheat by connecting up an incandescent lamp via the GPO socket. Note that you must use a lamp that is at least 60W. A smaller bulb rating may flicker since the Triac holding current is too high for these.

Press all three lefthand switches (Store Settings, Set UP and Dim Up switches) and wait as the slow in-

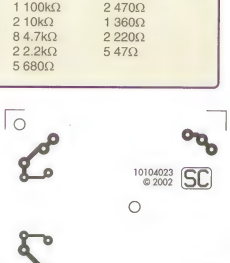


Fig.9: the is the full-size etching pattern for the filter PC board.

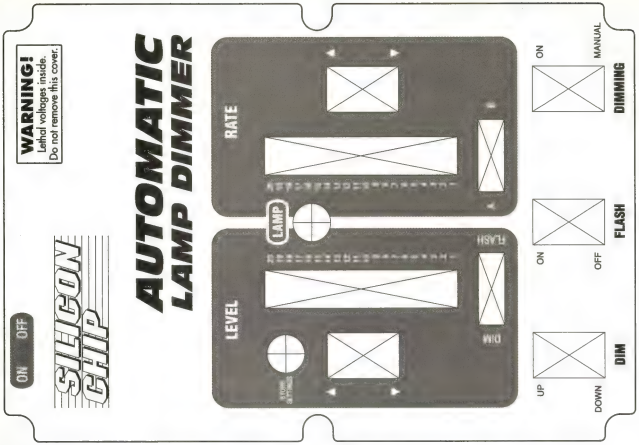


Fig.10: this is the full-size front panel artwork.

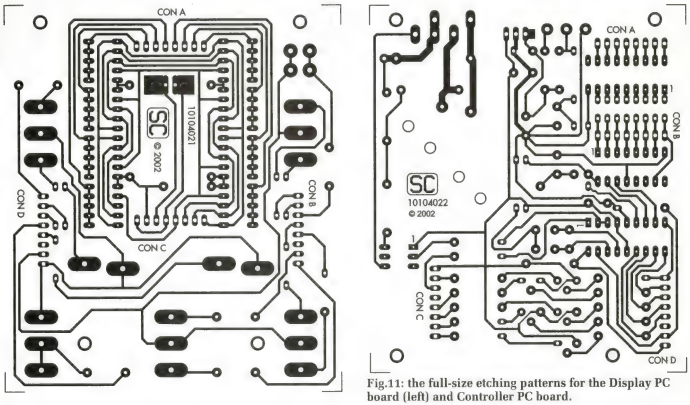


Fig.11: the full-size etching patterns for the Display PC board (left) and Controller PC board.

crease in voltage applied to the lamp is sufficient to provide a soft glow in the filament. Release the switches and press the Store Settings switch to retain this value of preheat.

Note that the dim up and set up switches may have altered settings at the time the filament preheat adjustment was made. You can store the dim and flash levels and A and B rates that you set on the display at any time using the store settings switch. **SC**

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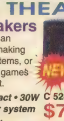

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D 0875	600VA	$323

Supplied complete with monitoring software & cables. 250VA will suit an average Pentium PC or firewall. The 425VA is suitable for faster PCs with more peripherals, where as the 600VA model is ideal for servers.

Not just for PCs!

Perfect for use on any equipment that needs to stay on during a power failure i.e. telephone systems, entry system, etc.

Features: Three battery backup GPO's plus 2 non backup GPO's • All outlets spike & surge protected • Fits standard 3 pin mains plug • RJ12/45 telephone spike protection • Comprehensive auto shutdown software • Circuit breaker protected

Precision Timer Modules

Automate your next project with these digital precision timer relays.
The S 0050/51 can both accept up to eight "On" times & eight "Off" times. The S 0060 has up to 14 programmed "On" times with a single set duration.

Features: Can be programmed for up to 15 combinations of day(s) • Choice of 24V or 240V models • Snap action mounting bezel • 24 hour clock • Manual override

	RRP	NOW
S 0050 24V Alternate action	$65	$45
S 0051 240V Alternate action	$65	$45
S 0060 24V Momentary action	$65	$45

KEEP YOUR CPU COOL

Ensure your CPU keeps its cool under pressure. Great for overclockers. Suits Pentium processors and features ball bearing fans for long life.

Save over 40%

Fans to suit Pentium II processors	RRP	NOW
F 2012 Two Fans	$24.95	$12.95
F 2013 Three Fans	$34.95	$19.95
Fans to suit Pentium III processors	**RRP**	**NOW**
F 2014 Two Fans	$26.95	$12.95
F 2015 Three Fans	$36.95	$19.95

Thermometer & Hygrometer

Ideal for use with fish tanks, home brew kits, greenhouses or tropical gardens etc.

Simultaneously displays both temperature & humidity. Storage and recall of maximum and minimum temperature & humidity.

SAVE 35%

Limited Stocks, be quick or miss out!

A 0150 RRP $45
NOW ONLY $29

Datalogging DMM

The Brymen® DMM is truly an amazing piece of test equipment with features only found in meters 2 or 3 times the price!
240V Rated. Meets EN61010–1 IEC1010–1, CAT II 1kVDC/750VAC. CAT III 600VAC/DC with 6.5kV transient protection!

Features: Auto ranging • EF Detect • Data Hold • Temperature • AC/DC Voltage 250mV–750V • AC/DC Current 250µA–10A • Resistance 250Ω–25MΩ • Diode Chack & Buzzer • Optically isolated RS232 Interface (optional Q 1082) • Optional temperature probe to suit (Q 1092)

Q 1080 RRP $160
ONLY $129

FREE Bonus Interface...

Purchase the Q 1080 for $129 & we will give you a Q 1082 datalogger RS232 interface valued at $26.25.

MAGNETICALLY SHIELDED SPEAKERS

All employ polypropylene cones for minimal flexing & distortion. High spec hi-fi loudspeakers for component systems or replacement speakers.

Save 50% on these speaker drivers. Be quick! At these savings the stock will not last!

	RRP	Now
C 3085	60W 5" M/Shielded	$48	$45/pair
C 3087	60W 6.5" M/Shielded	$52	$52/pair

POWERTRAN Powerboards

6 outlet

Power surges last a lasting just a fraction of a second can destroy valuable electrical equipment. These units include surge and RF EMI protection. The P 8151 also includes protection for telephone devices.

P 8141	Mains only, RRP $36.95	Now $25
P 8151	Mains + Phone , RRP $39.95	Now $28

BLACK & White CCD Dome

A high quality black & white CCD dome camera, perfect for discrete surveillance of homes, retail stores or offices.

Features: Samsung® sensor • 420 lines resolution • Full colour • 92° Lens • Fully adjustable

NEW

S 9110 RRP $129 ONLY $99

LAN Cable Tester

This unit will not only check all 8 conductors, but it will also check shielding integrity where shielded cable has been used. PLUS it can also check Coax wiring with the included BNC to RJ45 adaptor!

Features: Auto/Manual mode • LED indicators for all connections including Ground • Will test 10Base-T, 10Base-2 ,RJ45, 258A, TIA 568A/568B and Token Ring • BNC to RJ45 Adaptor included • Includes Soft carry case

D 3010 RRP $179
ONLY $149

Purchase the D 3010 for $149 & we will give you one of each of the adaptors below, valued at $42.00.

D 3024	RJ45 - BNC	$10.50
D 3025	RJ45 - USB "A" Type	$10.50
D 3026	RJ45 - PS/2	$10.50
D 3027	RJ45 - 8 Pin DIN	$10.50

11 Channel PRO AV Mixing Desk

This professional mixing desk is ideally suited for use in Clubs, Hotels, Casinos, Churches, Cabaret Bars, Karaoke Bars, Schools, Theatres & Live bands.

This month purchase the A 2650 for $780 and receive a C 0373 Gooseneck Microphone valued at $95.00

A 2650 RRP $998,
NOW $780
Save over $313!

Features: 8 mic/line channels & 3 stereo line input channels • Stereo inputs have 7 switch selectable source inputs with start/stop control • Master L & R (balanced XLRs) & Monitor L & R (RCAs) • 19" rack mountable • Faders for all channels • Pan for all channels • PFL on all channels • EQ defeat on all mono channels • Gain controls for all channels • Remote start for CD Players & Turntables • Separate level controls for Send & Returns on Aux. 1 & 2 • 3 Band EQ on all channels (sweepable mids on mono channels) • LED peak level indicators • Separate monitor level control • BNC light socket

Pocket LED Torches

Have these compact torches on hand, when you need them. The X 0195 is compact & robust, making it great for use in vehicles or when camping, fishing, bushwalking or cycling, whilst the X 0192 has a keychain & simple push on action making it ideal for finding keyholes in the dark.

NEW

X 0192 Pocket keychain light ONLY $14.95
X 0195 Pocket clip light ONLY $29.90

irodo. 50W GAS SOLDERING IRON

SMALL IN SIZE BIG ON POWER GO-ANYWHERE!

A gas iron for the busy technician, this little iron packs a HUGE 50 watts of heating power and will keep on going for up to 1 hour on a full tank!

T 2595 ONLY $36.50

Also available in a handy carry case pack.

T 2596 ONLY $69.95

Features: Four interchangeable tips: conical soldering, hot blower, hot knife & blowtorch • Variable heat output • Integral safety wire stand

SUPER SPECIAL! The first 100 callers to purchase a T 2595 or T 2596 receive a roll of T 1100 solder and a T 2449 Butane Refill, together valued at $11.50 FREE!

Impact Punchdown Tool

Seats wire into KRONE® and 110 style terminal blocks, making it perfect for LAN wiring, patch paneling. Ideal for technicians, IT personnel & electricians.

NEW

Features: Integral cable removal and seating tools • Replacement blades (T 1606) • Impact type

T 1602 ONLY $59

Authority Approved Cat 5e

Authority approved enhanced cat 5 cable, in a handy 305m pull box. Supports networks up to 155MHz!

W 2760 RRP $1.15/m ONLY $135/box

Dyna-Link Cat 5e

Prices and text inaccurate, all products are covered by a 12 month minimum warranty

Online ordering: www.altronics.com.au • fax order line 1-300 789 777

ALTRONICS

14 day money back guarantee

NEW KITS FOR 2002

MULTI-POWER BENCHTOP R & D MATE

(SC 'April 2002) An inexpensive, but extremely flexible piece of benchtop equipment, ideal for R & D of multiple projects. ***Features:*** Six selectable steps- ±3.5 ,6 ,9, 12 & 15V DC • Use 9-15V range at the same time as 3-6V range • Regulated rails • Independent load automatically re-connects battery power

K 3200
$89.95

"KNIGHT RIDER" LED CHASER KIT

(SC 'May 2002) Create a variety of visual effects with this 32 LED chaser project. Ideal for use in a visual display. ***Features:*** 12 switch selectable light patterns • Adjustable pattern speed • Adjustable LED brightness • 2 pattern medleys • 12VDC supply required

K 5815 **$44.95**

BATTERY GUARDIAN KIT

(SC 'May 2002) Stop your car fridge from running your battery flat. ***Features:*** 10A rating • Low power consumption • Cutout alarm • LED indication of cutout • Automatically re-connects battery power

K 4080
$47.95

8 CHANNEL IR REMOTE VOLUME CONTROL

K 5600
$249

FREE! An A1013 remote control with every K 5600, valued at $36.00.

(SC 'Mar/April 2002) Use one IR remote control to simultaneously adjust the volume of up to 6 channels. Perfect for Dolby 5.1 channel, active speaker & DIY surround sound systems.

Features: Attractive slimline 12 case, prepared and punched for front panel mounting • Compatible with all popular IR remote controls • 12 CH + Zero = All On and Inhibit • Minimal signal degradation • Low noise design • 240V operation

REMOTE TOUCH PLATE DIMMER

(SC 'Jan 2002) Replace that old fashioned light dimmer with a modern looking touch plate dimmer. ***Features:*** Slimline appearance • Soft start for lamp • Last dimming setting restored when switched on • Remote control operation • RFI suppression

K 6030
$69.95
A1013 Remote to suit $36.00

Touchscreen Learning Remote

Very simple to program and operate. Replaces up to eight remote controls plus adds up to 10 one-touch macro functions for armchair comfort. ***Features:*** • Auto power save • Useable with all modern AV equipment (e.g. DVD) • Stylish touch-screen display •Adjustable Backlit display • Smart & easy to programme • Requires 4xAAA batteries

A 1001 RRP $229 Now **$179**

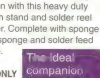
SOLDERING IRON STAND WITH SOLDER HOLDER

Create a tidy little soldering station with this heavy duty bench stand and solder reel holder. Complete with sponge tray, sponge and solder feed guide.

T 1306 ONLY **$24.95**

The ideal companion for the T 2420

NO NEED FOR SOLVENTS



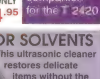
This ultrasonic cleaner restores delicate items without the need for nasty solvents. ***Features:*** 170 x 90 x 55mm stainless steel tank with a capacity of 600mls • Cleans without scratching delicate jewellery or glass • Auto power off • Uses water & household detergent

Ideal for cleaning jewellery, automotive parts, drafting pen nibs etc

A 0102 RRP $249
ONLY **$199**

40V 1A Power Supply Kit

(SC July. '2000) Suitable for use as a bench top/ Laboratory power supply. Output voltage is continuously variable from 1.23 to 40V, at up to 1A. Supplied in a rugged steel case, it features a precision LC display for voltage & current. It even features variable current limiting.



K 3250 RRP $149.95
Now **$119**

INSPECTA-GADGET ILLUMINATED MAGNIFIER

Features:
- Mounts easily to a table or desk edge
- Spring loaded adjustable arm
- SAA Approved
- Lens cover
- 240V operation

A 0970A
RRP $129
NOW ONLY
$99

Identify those impossible to read micro miniature components, without straining your eyes. Uses are not only limited to electronics, of course. It's ideally suited to stamp and coin collectors, model makers, seamstresses, jewellers etc.

MICRON 20W Soldering Iron

This powerful 20 Watt soldering iron

features a high efficiency patented heating element and a long life interchangeable iron-clad tip. It's supplied with a 1.6mm conical tip that is ideal for general assembly work. 3 different tip sizes available, 370°C fixed temp.

T 2420 RRP $34.00
Now **$29.95**

20MHz Dual Trace 4 Beam Oscilloscope

With the increasing complexity of electronic circuits a high quality oscilloscope is an absolute necessity for service techs & serious enthusiasts alike. ***Features:*** Wide bandwidth and high sensitivity • Very low power consumption • High sensitivity X-Y mode • Z axis (intensity modulation) • Simultaneous display of original and magnified waveforms on each input • Front panel electrical trace rotator • Regulated power supply circuit for accuracy • TV video sync • High frequency rejection filter in the triggering circuit

Q 0150 RRP $799
Now **$649**
Q 0174 Probe to suit $41.50

Save $150!

COLOUR CCD DOME

A colour CCD dome camera that's ideal for retail stores & commercial surveillance. ***Features:*** Panasonic® sensor • 330 lines resolution • Full colour • 92° Lens • Fully adjustable

S 9116 RRP $249
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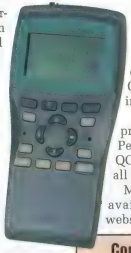
PRODUCT SHOWCASE

5MHz Personal LCD Handheld Oscilloscope



The 5MHz Velleman Personal Oscilloscope has high sensitivity and extended scope functions, making it suitable for measuring audio equipment, digital signals, mains voltage applications and car hifi just to name a few.

It gives users a high contrast LCD with a wide viewing angle, full automatic setup for volt/div & time/div, true RMS and dB measurements, screen hold function, low battery detection and auto power off.

The scope is housed in a durable ABS plastic case which includes a tilting bail and tactile-style rubber switches. A handy neoprene/nylon zip-up carry case and a standard test lead are also included.

The scope also has a handy optional feature that allows you to select different display aids such as a Grid that divides the screen into reference points.

With a recommended retail price of $319.00, the Velleman Personal Oscilloscope (Cat no. QC1906) is available through all Jaycar Electronics stores.

More information is also available on the company's website.

Contact:
Jaycar Electronics
PO Box 6424, Silverwater NSW 1811
Ph: (02) 9741 8555 Fax: (02) 9741 8500
website: www.jaycar.com.au

Reach for the stars – or at least look at 'em!

Here's a great gift for the budding astronomer at your place: a 60mm refracting telescope, complete with a 60mm objective lens and 1.5x erecting lens. A variety of eyepieces are included including F10mm, F15mm H and F25mm K, along with a right-angle adaptor, a 5x24 "finderscope" and a 3x Barlow lens.

It has a standard mount and includes the wooden tripod (shown).

Recommended retail price of the telescope is $148. It is available through all Dick Smith Electronics stores and DSE PowerHouse stores, most dealers and via mail orders.

Contact:
Dick Smith Electronics
Ph: (02) 9642 9100 Fax: (02) 9642 9153
website: www.dse.com.au

Anyone *really* into computer games?

If you (or anyone else in the family!) like *really* getting into PC games, Oatley Electronics has a bargain for you.

These brand new "Thrustmaster" steering wheel/pedal sets can be used with any PC (full instructions and drivers on CD are included) and the wheel clamps on to any table. It has four on-wheel buttons and two paddles for gear changes, etc. Price is just $69.00 each.

Oatley also have some great game bargains to go with them: Eidos Formula 1, Eidos Daikatana and Eidos Deathtrap for $18 each, or all three games and the Thrustmaster for $100 (a saving of $23).

Note stock is limited!

Contact:
Oatley Electronics
PO Box 89, Oatley NSW 2223
Ph: (02) 9584 3563 Fax: (02) 9584 3561
website: www.oatleyelectronics.com

New Wiltronics and Rockby catalogs released

It's catalog season. Recently the Altronics and Jaycar Catalogs have appeared (SILICON CHIP readers received a complimentary copy) and now the Wiltronics Research and Rockby Electronics 2002 catalogs are available. The Wiltronics catalog is a conventional (paper) A4-size with 100 pages, while the Rockby catalog is on CD-ROM. More information from their respective websites.

Psst! Your Dick Smith Electronics 2002 catalog will be in June SC!

Contact:
Wiltronics Research Pty Ltd
Ph: (03) 5334 2513 Fax: (03) 5334 1845
website: www.wiltronics.com.au

Contact:
Rockby Electronics Pty Ltd
Ph: (03) 9562 8559 Fax: (03) 9562 8772
website: www.rockby.com.au

Jaycar's new Chipkartenleser

Huh? OK, just in case you don't speak German (we think!) Jaycar has just released a new product: a handy Sim Card Reader.

The Reader allows you to download Sim Card data to your computer. It can then be stored, managed, shared, or simply used to print the data stored in the Sim Card of any mobile phone.

Once the information is downloaded it is then possible to update it and write it back to the card. The reader can change the phone's PIN and will even create backups of SMS data and phonebook.

This is especially useful if one is changing phone companies or sharing a common phone book on several phones. The reader attaches to the computer via the serial port and will accept both full-sized and miniature SIM Cards. Recommended retail price is $39.95.

Contact:
Jaycar Electronics
PO Box 6424, Silverwater NSW 1811
Ph: (02) 9741 8555 Fax: (02) 9741 8500
website: www.jaycar.com.au

16MB "Go Anywhere" storage drive

It's about the size of a highlighter pen and clips onto a shirt pocket or key ring – and can store up to 16MB of information to take wherever you go.

The Targus "Go Anywhere" StorageDrive is fully plug-and-play in operation, with no driver, power supply or battery required. It plugs into any USB port on Windows (98/2000/ME/XP), Mac (OS9 +) or Linux-based (2.4.0) system. The host computer immediately detects it, recognising it as a supplementary removable disk and assigning it a drive letter.

The KeySafe security application ensures confidentiality of data by means of user-defined password and internally-secured access verification.

The Targus "Go Anywhere" drive is available wherever computers are sold for around $129.

Contact:
Targus Australia Pty Ltd
117-119 Bowden St, Meadowbank, NSW 2001
Ph: (02) 9807 1222 Fax: (02) 9807 3555
website: www.targus.com.au

New receiver, active sub from Denon

New from Denon are the 50 watt/channel DRA-295 receiver (rrp $599) and Martin Logan Descent, an active 400 watt subwoofer system with an rrp of $7,950.00

In the remote-controlled amplifier, the power supply, power amp, tuner and preamp stages are all kept separate.

The Martin Logan Descent is an active 400 watt subwoofer system that employs three 10-inch drivers in parallel utilising an advanced servo monitor and control. With less than 0.07%THD at all levels, the Descent is unquestionably one of the lowest distortion subwoofers on the market. It is equally at home in both 2-channel and multi-channel Home Theatre systems. Frequency response is from 200-150Hz ±3dB with switchable crossover points at 40 and 70Hz. Inputs are RCA line levels and XLR LFE.

Contact:
Denon
GPO Box 2301, Sydney NSW 2001
Ph: (02) 9560 6266
email: sales@kedcorp.com.au

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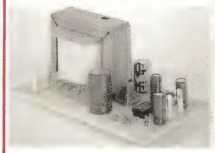

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Ph (02) 9476-5854 Fx (02) 9476-3231

Register your business with Australe

Businesses wanting international exposure are being invited to register on Austrade's Australian Suppliers Database.

The Australian Suppliers Database is a comprehensive, searchable directory of Australian companies accessible by potential buyers anywhere in the world.

Run by the Australian Trade Commission (Austrade), the database already lists around 7000 Australian suppliers. It allows companies to touch base with buyers overseas.

The database is widely promoted through Austrade's 90 offices located throughout Australia and the world.

Listing on the database is a free service that will include your products and services, your company message and your contact details.

Contact:
Austrade
GPO Box 2301, Sydney NSW 2001
Ph: (02) 9390 2077 Fax: (02) 9390 2341
website: www.austrade.gov.au

SILICON CHIP WebLINK

How many times have you wanted to access a company's website but cannot remember their site name?

Here's an exciting new concept from SILICON CHIP: you can access any of these organisations instantly by going to the SILICON CHIP website (*www.siliconchip.com.au*), clicking on WebLINK and then on the website graphic of the company you're looking for. It's that simple. No longer do you have to wade through search engines or look through pages of indexes – just point'n'click and the site you want will open!

Your company or business can be a part of SILICON CHIP's WebLINK. For one low rate you receive a printed entry each month on the SILICON CHIP WebLINK page with your home page graphic, company name, phone, fax and site details plus up to 50 words of description–and this is repeated on the WebLINK page on the SILICON CHIP website with the link of your choice active. Get those extra hits on your site from the right people in the electronics industry –t he people who make decisions to buy your products. Call SILICON CHIP today on (02) 9979 5644

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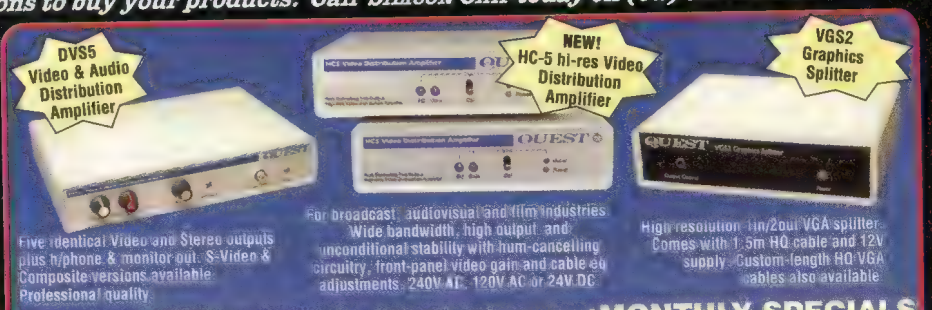
www.rfprobes.com.au



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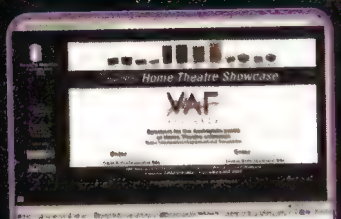

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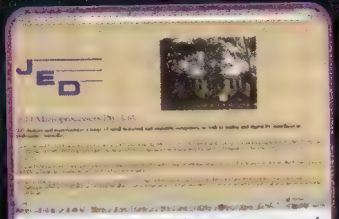

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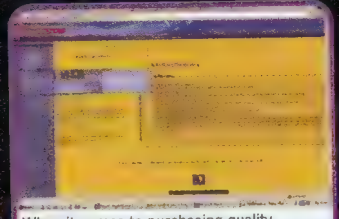

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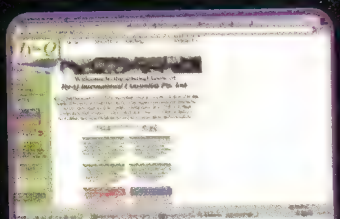

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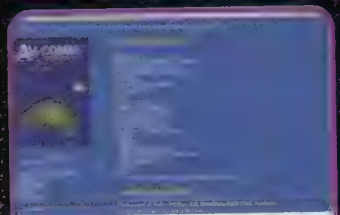

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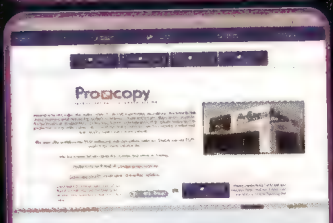

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Wind-up energy is about to make a resurgence

WOUND UP A

by Gerry Nolan

Wind-the-handle, magneto telephones were common in rural areas until the late 60s (I used one myself as late as 1965) and now the handle is back. Wind-up mobile telephone chargers are just about to be released in Australia.

Since, as someone said recently, 'A mobile phone with a flat battery is as useless as a hip pocket in a singlet,' a lightweight charger that depends on nothing but human energy will be a boon to those people who find themselves with a flat mobile battery and no power source in the vicinity.

Wind-up radios have been around for several years and wind-up torches have been a more recent development. Also known as self-powered energy, the technology has evolved from the fairly clunky Mark 1 wind-up radio to the sleek Freeplay Ranger with the choice of wind-up, solar and rechargeable power. Of course, a long time before any of these developments, wind-up energy storage was commonly used in gramophones, toys and rubber-powered model aeroplanes.

Since the production of the first "Freeplay" radio in 1996, over 150,000 have been brought to communities in at least 40 developing countries. It is estimated that these radios have already directly benefited over three million people and up to 30 million indirectly. While this seems to be a large ratio, the radios are used for example in schools where there is no electricity, for entertainment as well as education.

A major use of the radios is in emergency situations around the world, a striking case being the unprecedented floods in Mozambique in the Spring of 2000. The Freeplay Foundation donated thousands of radios to people who had lost their homes and possessions to enable them to access vital health and safety information. So successful were the communications that additional FM transmitters were imported to improve reception in remote areas.

Back to mobile phones...

A technical collaboration between Freeplay and

The Freeplay wind-up mobile phone charger, shown about life-size (at right) and in use (above). A 30-second wind will give enough power for a few minutes talk time.

OUT ENERGY

Motorola puts an end to the mobile phone with the flat battery.

Known as the FreeCharge, the unit incorporates a winder handle, gearbox, alternator, rectification, power conditioning, intermediate battery storage cells, energy input charge indicator and power output socket. The internal battery can be charged by either the human-powered alternator or an AC/DC adapter and energy supplied to the mobile phone as required.

Winding the charger for 30 seconds will supply energy for about 4-5 minutes talk time (depending on the type of mobile phone) and several hours standby. Winding for an accumulated 35 minutes fully charges the internal battery of the charger.

This is a non-removable, Ni-MH battery pack, with a capacity of 3.5V and 1,000mA hours, or about the same as the handset battery. A LED charge level indicator illuminates when the optimal charge rate (winding effort) is reached, but the more vigorously you wind the more energy is supplied to the mobile phone, extending the talk time proportionately.

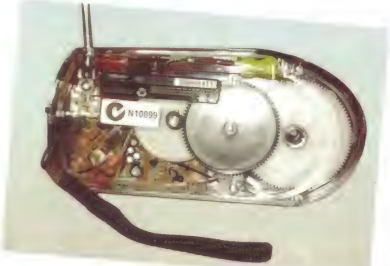
A 24 hour charge via the AC/DC adapter will also fully charge the battery.

At 52x145x60mm and weighing 230g, the FreeCharge units are about twice as large as the average mobile phone and weigh considerably more but the size and weight are expected to decrease as the technology develops.

At present the adapter module range covers about 80% of the current model mobiles and will expand as new models are introduced.

With wind-up technology improving the way it is, perhaps it won't be too long before larger equipment, such as motor vehicles will use spring storage instead of fuel or batteries. After all, you could drive into a service station for a quick wind-up using an electric motor.

We've come a long way from the wind-up gramophone but it's a circular path. SC



Above is the Global Shortware wind-up radio, distributed in hundreds of thousands to third-world coutries. Below is the AM/FM Freeplay S360, partially disassembled to show some of the wind-up mechanism. It also runs from solar energy or rechargeable batteries..

Stepper Motor Controller

By Ross Tester

With so many stepper motors in use (and disposed of) these days, one of our most-asked questions is "how do I use one?" Here's how . . .

Stepper motors are everywhere. For example, every computer contains several (in the floppy and hard disk drives – one popular hobbyist source). They're used because it is easy to achieve very precise positional control – far better than you can achieve with a "normal" motor (if you can control it at all).

Unlike a conventional motor, where you simply connect an appropriate voltage and "away she spins", stepper motors require considerably more effort to get them to work.

So what is a stepper motor?

First of all, think of a conventional motor. It has two main components – a stator, which sets up the magnetic field, and a rotor, which by magnetic attraction or repulsion turns toward or away from the magnetic field.

But there's also a commutator (actually part of the rotor) which keeps switching power from one coil to the next, moving the magnetic field as well, so the rotor has to keep moving, or rotating. Yes, that's a pretty simplistic explanation – but will suffice for our purposes.

Stepper motors are similar in many respects – they have stators and they have rotors – but they don't have commutators. The magnetic fields which cause attraction/repulsion, and therefore turning, are set up externally by the motor controller.

A stepper motor operates a little like a chaser: one stator coil is energised, repelling the rotor. Then that coil is de-energised and the next one energised, again repelling the rotor. Keep this up and the rotor turns continuously.

The rotor may be either a permanent magnet, a variable reluctance or a combination of both.

By controlling which field coils are energised and when, the rotation and stopping position of the rotor can be extremely closely controlled. You will hear stepper motors referred to as 0.9°, 1.8°, 3.6° and so on. This refers to the rotation of one "step" in the motor – a 0.9° motor will have 400 individual steps to make one full rotation of 360°.

As you can see, 400 steps in one rotation is a lot of steps, especially as each one can be individually accessed. (To rotate the shaft 135°, for example, you simply instruct it to step 150 times). And many stepper motors operate through a gearbox, multiplying that precision yet again.

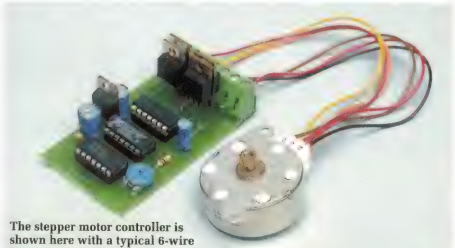
The speed of rotation is obviously directly related to how fast you can switch current between the coils. At low speeds, there is no problem – but as the switching frequency increases, we can start to get into difficulties.

Loss of power

At low speeds, most stepper motors are generally quite powerful devices – ie, lots of torque – especially when driven by an appropriate supply.

However, most hobbyists tend to drive a stepper motor from a fixed voltage supply. This is fine at low speeds (low frequency) but as the speed increases, the torque drops off, often dramatically, due to the coil impedance.

There are three main methods used



The stepper motor controller is shown here with a typical 6-wire disposals stepper motor.

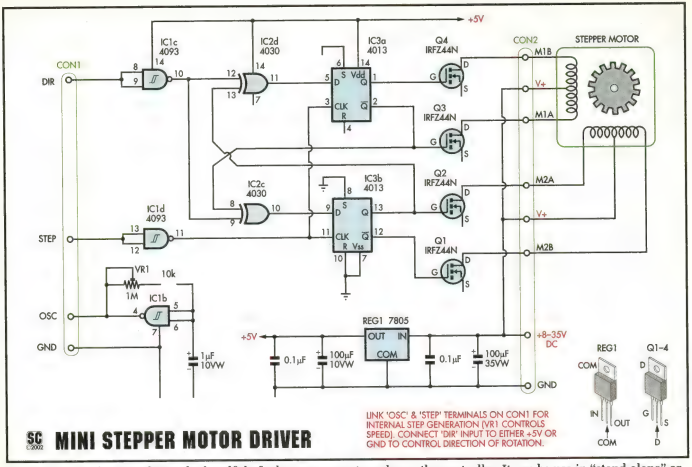


Fig.1: three ICs, four Mosfets and a handful of other components make up the controller. It can be use in "stand alone" or computer-controlled modes.

to overcome this reduction in torque:

1 – The use of a higher voltage switched-mode power supply that increases the duty cycle at higher motor speeds.

2 – The use of a higher voltage power supply along with a power (ballast) resistor in series with the motor. The resistor limits the current to that of the nominal motor current.

3 – The use of a constant current source that maintains constant current to the motor at all speeds. As the speed increases, the voltage also increases.

There are disadvantages in the first two methods. Switched-mode (some times called "chopper") power supplies need to be carefully tailored to suit the specific motor being used and its torque curve. So it's hard to make a "universal" supply.

The ballast-resistor method results in less current being applied at higher speeds and is therefore less efficient.

However, the use of a constant current source ensures the motor current remains constant throughout its speed range. Although this method is perhaps wasteful compared to the "chopper" due to the heat generated in the driver, it requires little or no setup. In practic,e this type of circuit is already proven and is in common use in industrial drivers.

How it works

This controller operates in either free-standing or computer-controlled

Parts List - Stepper Motor Controller

1 PC board, 72 x 42mm, coded K179 (Oatley Electronics)
2 3-way PC-mount terminal blocks
1 2-way PC-mount terminal block
1 4-way PC-mount header pin set (or 4 PC stakes)

Semiconductors
1 4093 quad 2-input NAND Schmitt Trigger IC(IC1)
1 4030 quad exclusive-OR (IC2)
1 4013 dual D flipflop (IC3)
1 7805 5V regulator (REG1)
4 IRFZ44N Mosfets (Q1-Q4)

Capacitors
1 100µF 35VW
1 100µF 10VW
1 1µF 20VW
2 0.1µF polyester

Resistors (0.25W, 5%)
1 10kΩ
1 1MΩ PC-mounting preset pot

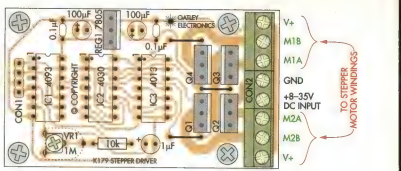


Fig.2: be careful when soldering in the ICs: the tracks are closely spaced!

modes. In the free-standing mode, an internal square-wave oscillator based on IC1b supplies timing pulses to the "OSC" output. The frequency of these pulses (and therefore stepper motor speed) is controlled by preset pot, VR1. (A standard 1MΩ linear pot could be substituted to allow external speed control at any time).

Either the oscillator pulses or control pulses from a computer are fed into the "STEP" input which in turn are buffered and inverted by IC1d, a 4093 Schmitt trigger. This helps prevent false triggering.

Similarly, IC1c buffers and inverts the "DIR" (direction) input which once again can be either manually set or taken from a PC. Taking the DIR input to +5V causes the stepper to turn in one direction; taking it to GND will reverse the rotation.

IC2c and IC2d (4030 exclusive OR gates) invert the outputs available at the Q and Q-bar outputs of each of the flipflops, IC3a and IC3b.

The incoming step pulses clock the flipflops, thus toggling the Q and Q-bar outputs and this turns the MOSFETs on or off in sequence.

The IRFZ44 Mosfets have a very low on-resistance and can deliver 5 or 6A each without heatsinking. For higher current use, small clip-on heatsinks could be used or the Mosfets could be removed from the PC board and placed on a larger heatsink.

The power supply is a conventional circuit using a 7805 3-terminal regulator, producing 5V output. A minimum of about 8V DC is required at the input and the maximum (limited by the 7805 rating) is 35V.

Construction

All components mount on a single PC board measuring 72 x 42mm, coded K179. This board is only available as part of a complete kit from Oatley Electronics.

It is perhaps easier with this board to depart from normal practice and solder in the three ICs first. The reason for this is that there are tracks going between the IC pin pads and these will require very careful soldering and checking.

Make sure you get the three ICs in their right places and the orientation is correct (all three face the same way).

Next, solder in the resistors and capacitors and use some of the lead cutoffs for the three links. Solder in the header pins, the on-board terminal blocks and finally the regulator and the four Mosfets. Note that the Mosfets are NOT oriented all the same way – and it's important to keep their drains (the metal tabs) separated from each other, especially if you fit heatsinks.

(If you decide to mount the Mosfets on a larger heatsink, as mentioned above, you will need to fit insulating washers and bushes to each Mosfet to ensure they are electrically isolated from each other).

Before use, check and double check your component placement and soldering – especially the ICs as noted above.

In use

It's outside the scope of this article to go into much detail. It's sort-of like "if we need to explain then you shouldn't be doing it!"

However, a quick note on using surplus steppers: as you can see from the circuit diagram, the windings on most of the steppers you will come across are centre-tapped. This means you can usually identify the pairs with a multimeter, as well as working out which is the centre tap.

Having got that far, connect up the circuit with the "OSC" and "STEP" pins shorted to each other, plus the "DIR" and "GND" pins to each other. Connect the centre-taps of your stepper motor windings to the V+ terminals and their pairs to the M1B and M1A, M2A and M2B terminals as appropriate. Set VR1 to half-way.

Apply power and see if your stepper is continuously turning. If not (eg, if it is "hunting"), swap the M1B and M1A windings only (leave M2A and M2B) and check again. Now it should be turning. Varying VR1 should vary the speed up and down.

If it doesn't work, check to see if IC1b is oscillating (an analog meter on a low voltage [<10V] setting connected between OSC and GND should show up and down deflection, especially with VR1 set to its maximum).

If so, check the voltage between each of the motor terminals and ground with your meter set to a bit higher (say <50V) and see if the meter deflects. At the oscillator's higher speed range, you probably won't see any movement – the meter will read the average voltage.

If this test proves OK, you probably have a dud stepper motor!

Computer control

There is quite a range of stepper motor controller freeware available on the 'net. Google "Stepper Motor Software" or words to that effect and see

Software

Here are just a few of the demoware or shareware downloads available from the net.

Name: DANCAD
Download from: *www.metalworking.com*
Runs under: DOS
Number of axes: up to 4
Features: Extensive printable manual with printer port connection diagrams, etc. Able to be configured to suit most applications, (lathe and mill etc.) including angular and linear axis set up. Dancad is able to be set up with a tangential knife for sign cutting.
Imports: HPGL

Name: KCAM
Download from: *www.kellyware.com/index.shtml*
Runs under: WIN9X.
Number of axes: 3
Features: Gives a 2D or 3D view of the item to be machined, manual jogging, controller and table setup to suit most machine tables including backlash compensation. Tool paths can be programmed in its Gcode editor, or imported as DXF, NC, and PLT files. Ideal for engraving signs and plates, drill PC boards, mill parts, plasma cuts, PCB isolation. Conversion from Gerber (RS274X) files or plot pictures.
Loads: G&M code files,
Imports: Excellon ASCII drill files, DXF files, HPGL files PLT, Gerber files GBO
Exports: G&M code files

Name: STEPSTER
Download from: www.*thegallos.com/stepster.htm*
Runs under: DOS
Number of axes: up to 6
Features: Simple to use and set up, Able to be configured to suit most applications, (lathe and mill, etc.), including angular and linear axis set up.

Name: EMC
Download from: *www.isd.mel.nist.gov/projects/emc/*
Runs under: LINUX
Number of axes: up to 6
Features: Hard to set up. Able to be configured to suit most applications (lathe and mill, etc.), including angular and linear axis set up.

what you come up with. We have given a few sources in this article but there are lots (and lots!) more.

Most of the software available uses the same connections to your PC's printer port:

Pin	Function
2	X axis step
3	X axis direction
4	Y axis step
5	Y axis direction
6	Z axis step
7	Z axis direction
8	C axis step
9	C axis direction
18-25	GND

The other printer port pins vary according to the particular software – they are often used for limit and home switches.

Depending on the software used, up to 6 motors (with 6 controller boards) can be controlled just by connecting the stepper drivers to the printer port of your computer.

In other words, complete three-directional control is possible (we hope to have more on this in a future issue).

Where do you get it?

This project is available as a complete kit of parts from Oatley Electronics. Contact details can be found on page 15 of this issue. **SC**

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VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG

The AWA FS6 army transceiver

A significant number of vintage radio buffs collect and restore amateur, military and commercial radio equipment. Along with the more familiar domestic radio gear, this equipment is also a part of our radio heritage and an interesting part of it at that.

The front panel layouts of military radios are purely utilitarian and they don't look a million dollars in matt khaki or some other unexciting colour. Aesthetics was not one of the design principles and there are no elegant timber consoles here. However, it is interesting to compare them in many ways with the domestic radios of the same era.

During WWII and on the military surplus market in the late 1940s and early 1950s, the FS6 high frequency (HF) portable army transceiver was common. Many amateur radio operators modified them for use on amateur radio bands and they were also used by bushfire brigades, the Flying Doctor Service (WA), fishermen and other organisations.

This view shows the FS6 transceiver with the valve access panel open. Military equipment was designed so that all valves were accessible via a single panel.

However, the FS6 is not the sort of gear that the majority of vintage radio buffs collect. There are various reasons for this, the most common being that there are now very few such units around.

General description

The 1943 provisional training manual on the FS6 gives us a few pertinent facts about the equipment, which I have paraphrased. It is quoted as a medium range, portable combination sender-receiver, suitable for point-to-point communication. It has a frequency range of 4.2-6.8MHz and will operate on both W/T (CW telegraphy, Morse) or R/T (radio telephony).

For transporting over short distances, the set can be classed as a 2-man pack. The weight of the station is listed at 157lb, or about 71.4kg (I'm glad they said "short distances") and it can be used as a ground station or as a mobile truck station.

The receiver has two headphone outlets so that two operators can operate the set at the same time. The receiver is a 5-valve superheterodyne with AVC, while the sender (transmitter) has three valves consisting of a master oscillator, a modulator and an RF power amplifier.

The power source is a 6V, 75Ah battery. A 6V vibrator power supply provides all of the HT and bias voltages and the set draws 3.2A on receive and 6.0A on transmit W/T. If a pedal generator is used, only a 25Ah battery is needed to power the set.

Background to the FS6

Prior to WWII, the military had a variety of specifications that had to be met when supplying equipment for their particular needs. One particular specification for radio equipment specified that the valves should all be

This is the complete FS6 station, with the power supply unit at right.

accessible through a hatch in the front of the case. This is clearly shown in one of the photographs of the transceiver – here, the hatch (or cover) has been left open and all the valves are clearly visible.

This made valve replacement an easy task. However, there was a real disadvantage in that the valves could not be placed in their optimum positions for stable operation, maximum gain or highest frequency operation. I suspect that this requirement came into being around the end of WWI when valves were very unreliable and hadn't been rescinded by the outbreak of WWII.

In the late 1930s, AWA produced a predecessor for the FS6 designated the 101. I don't know exactly when it was produced but I suspect that, at the time, it was the most modern set of its type, using the recently produced octal battery valves. It was a very low-powered set, mounted in the same cabinet as the FS6 and supplied with power from a slightly smaller power supply.

The 101 struggled to provide an RF output of 0.4W on voice and 0.8W on CW, whereas its successor, the FS6, put out 4W and 8W respectively – a big improvement. However, to the untrained eye, the 101 looks the same as the FS6.

I suspect that AWA was asked to provide an updated, more powerful version of the 101, that looked virtually the same and could be used in the same way as the 101 (although I have no firm evidence for this). For example, the microphone, headphones, connectors and the like would have to be interchangeable between the two types.

The receiver remained the same in each set (101 or FS6) as it had proved to be quite satisfactory. The transmitter though was a complete redesign but was still be capable of fitting into the original space allocated for it in the 101.

Valve lineup

The 101 used all battery valves. A 1K5G acted as a master oscillator with two parallel 1K5Gs in the RF output stage. Voice modulation of the 1K5G output stage was achieved by impressing the voice signal onto its grid. Carbon microphones are high output units and there was sufficient audio energy put out to modulate the transmitter output stage when fed through a microphone transformer.

The transmitter was redesigned to use a 1L5G as the master oscillator and the ubiquitous 807 small transmitting valve as the output stage. However, it was more difficult to modulate the grid of the 807. As a result, another 1L5G was added after the microphone transformer to boost the audio to a sufficient level to modulate the transmitter effectively.

Another of the photographs shows the equipment assembled and almost ready to operate, needing only a battery and an antenna and earth to complete the installation. The microphone rubber mouth piece had perished, so it is no longer fitted. Normally the

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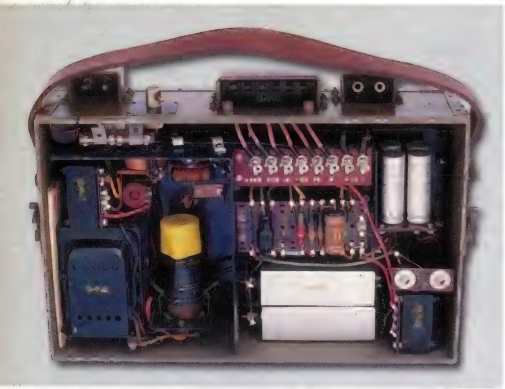


This view shows the FS6 power supply with the access cover removed. The vibrator is at bottom left.

power supply is stood to the left of the set and the headphones should be low impedance. The cabling between the power supply and the transceiver is made in such a way that it is impossible to interconnect them incorrectly.

The receiver is located in the righthand section of the cabinet while the transmitter is on the left. The receiver has relatively few controls and they don't follow the general layout used on domestic receivers.

Starting at the top left, the control here is the aerial tuning control, which is used to peak the performance of the receiver on different aerials. Once set, it can be locked in position by its central knob. At the far right is the volume control, with the earth terminal nearby.

The tuning control is in the centre, with the vernier tuning control just to the right of it. On the far right are the parallel headphone sockets. At the bottom left is a toggle switch which changes the operation of the receiver from voice (radio-telephone) to Morse code (wireless-telegraphy) – ie, this is the mode switch.

Above the mode switch is a "mystery" circular black bakelite holder of some sort. These devices were a mystery to me for some time and are mounted on many military radio transceivers. They are a holder for a fob watch. It was necessary to have a watch in a secure spot so that radio schedule (skeds) times could be kept.

The transmitter front panel is a little more crowded than the receiver. At the top left is the earth terminal, with the mode switch (speech-key) alongside it. In the centre top is the aerial current meter which is used when tuning the transmitter for maximum output power. Alongside it to the right is the aerial terminal and just below that is the "send/off/receive/net" switch which controls the switching between the transmitter and the receiver.

On the bottom left are the variable frequency oscillator controls. There is a locking knob in the centre of the frequency control knob and a rubber drive vernier onto the edge of the main control knob. The two controls at bottom right are used together to tune and match the transmitter to the aerial. Alongside these controls is the microphone jack.

The Morse key is set into the valve access cover and is slid out when it is to be used. Alongside it is a jack which is used for remote control of the set. However, remote control of sets like these is rather limited in scope compared with what is expected from modern remote controls.

The power supply is in the separate case at left and has only one control which is the on-off switch. It also has three plug/socket connections to go to the transceiver and the battery.

The receiver

The receiver has a conventional superhet circuit typical of the era. The converter uses a 1C7G, followed by a 1K5G first IF amplifier on 460kHz, then a 1K7G as a second IF amplifier, detector, AGC detector and reflexed first audio. Following the 1K7G, audio is applied to another 1K7G which feeds a pair of low-impedance headphones via a transformer.

The basic circuit is similar in many

Photo Gallery: Tasma Model 22

TASMA MODEL 22: manufactured by Thom & Smith, Sydney in 1931, the Tasma Model 22 is a 3-valve TRF receiver with the following valves: 224 detector, 247 output and a 280 rectifier. (Photo and information courtesy of Historical Radio Society of Australia).

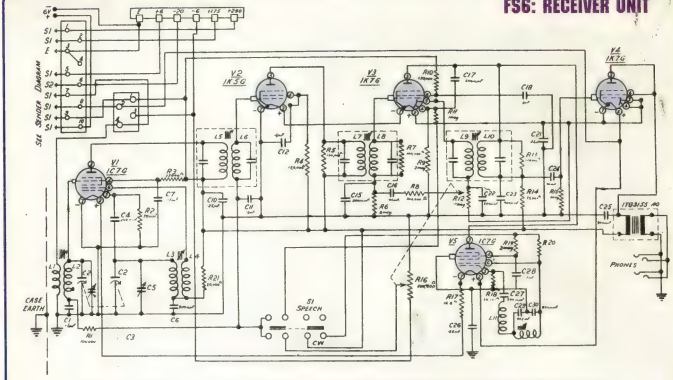


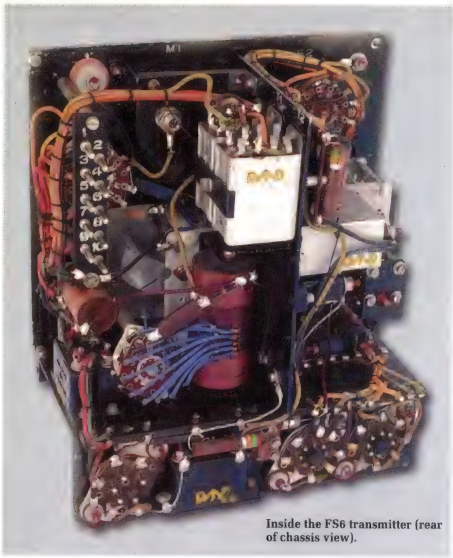
Fig.1: the FS6 receiver unit employed a conventional superheterodyne circuit with five valves.

ways to sets such as the Fisk Radiola 184 of 1939.

This set had a different job to do compared to the domestic receivers of the era and so there are noticeable differences in some areas of design. Portable military radios very rarely had loudspeaker output, for several reasons: (1) it was much easier to hear clearly what was being sent to you if headphones were used and this avoided mistakes; (2) quite a bit of radio traffic was for the officer in command only and no-one else (operator excluded); and (3) when the sets were used on the front line, you didn't want the enemy hearing what was going on or being able to pinpoint where you were.

The other major difference is in the use of a beat frequency oscillator, which is V5 (1C7G) in the circuit. When receiving Morse code messages, this oscillator – which operates at around 460 kHz in the FS6 – beats with the incoming Morse signal to give an audio tone. AGC systems of the era didn't work well with Morse code signals, so the AGC system is disabled and a variable bias is applied to the AGC line via a ganged volume control (R12 and R16 are ganged via a belt).

Inside the FS6 receiver (rear of chassis view).



Inside the FS6 transmitter (rear of chassis view).

By increasing the volume control, the volume setting is increased and the bias applied to the AGC line (via R16) is decreased, thus increasing the gain of the RF section of the set.

In operation, the receiver works quite well and is reasonably sensitive. The dual-speed tuning is easy to operate and, using the vernier dial drive, shortwave stations are tuned as easily as broadcast band stations on typical domestic radios.

This particular receiver needed no replacement components when it was refurbished back in 1973, although that situation may have changed by now of course. The receiver circuitry is removed by undoing four screws at the front of the set and pulling it out of the case.

Most military sets aren't particularly easy to service and the FS6 receiver appears to be no different. That said, a close inspection of the chassis reveals that much thought has gone into making the components relatively easy to access, despite the compact nature of the radio.

For example, the bottom adjustments for the IF transformers are easily accessed at the back of the set. On the other hand, the top adjustments are close to the front panel and at first sight, appear to be inaccessible. However, although not obvious in the photographs, there is a small panel on the front of the set that is removed to gain access to the IF transformer adjustments.

Should an IF transformer become defective, it is surprisingly easy to remove. Conventional wisdom has it that IF transformers are removed through the top of the chassis (plate) but this clearly impossible with the FS6, as the transformer top is hard up against the front panel. In this case, the transformer connections are unsoldered and then the mounting screws are removed. The transformer is then withdrawn through the underside of the chassis (plate) – nifty.

It is not possible to operate the receiver out of its case unless jumper leads are attached to the 4-pin plug shown in the top left of the circuit (see Fig.1). The connections are: (1) HT +175V @ 27mA (maximum); (2) filaments +6V @ 240mA; (3) bias -6V @ < 1mA; and (4) aerial/antenna. The chassis is the common return circuit for the HT and filament negative, the bias and the antenna system earth.

The sender (transmitter)

In this section I've gone into more detail than usual, as many vintage radio buffs are unfamiliar with the operation of transmitters. Generally an AM or CW transmitter has a simpler circuit than a superhet receiver but they are noticeably different from each other.

As with the receiver, the transmitter is removed from the case by undoing four screws and pulling it out. A rear view of the chassis is shown in one of the photos.

This is a reasonably simple transmitter, having just two stages in the RF section and one in the audio section. A 1L5G (V2) acts as the variable frequency oscillator (master oscillator or VFO) and determines the actual transmission frequency. It has temperature compensating capacitors (top left in circuit) to ensure that the transmitter's output frequency does not drift unduly when operating.

The VFO is similar to the local oscillator in a superhet receiver but works at a higher power level. The signal from the VFO is applied to the 807 where it is amplified. The output signal is then applied to the tuning and matching circuits consisting of C14, L2 and S3 which ensure efficient transfer of power to the antenna system.

The output circuit of the transmitter is not unlike the circuitry of crystal sets, where the antenna and diode detector are matched to the tuned circuit for best performance. It is necessary to have a transmitter working at optimum efficiency for several reasons: (1) to provide the maximum output power transfer possible (for maximum efficiency); (2) to keep the valve dissipation down; and (3) to economise on the use of electrical power

(important when using batteries).

In the Morse code mode (CW), the transmitter has grid block keying. This involves placing a bias of -20V onto the grids of the 1L5G (V2) and the 807 (V3), which effectively prevents the 1L5G from conducting and in the case of the 807, reduces the current drain to a safe level when the key is up. When the key is down, the bias is removed and the transmitter operates.

When the transmitter is switched to voice operation, the VFO (V2) runs continuously with no blocking bias. The 807 power amplifier operates using both fixed bias (-20V) and self-bias, the latter derived from half-wave rectifying the signal from the VFO at its grid. The voice signal from the carbon microphone is amplified by V1 (1L5G) and fed to the grid of the 807 via T2, the modulation transformer.

The voice signal is impressed onto the grid of the 807 in series with the -20V bias. The resulting variation in the bias causes the 807 circuit to act as a high-power mixer. Mixers have several signals in their outputs and, in this case, we have the VFO frequency, the audio frequency and the products VFO + audio frequency and VFO - audio frequency.

The circuit only passes the RF signals. The VFO signal is the carrier and the + and - audio signals form the upper and lower sidebands. These three components form the composite AM signal we are all familiar with.

The power supply

The power supply is quite large for the amount of power it provides to the transmitter and receiver.

As shown in one of the photos, there isn't a lot of spare space inside the case. The front cover is just clipped on by two catches, one on each end. But despite this being an imperfect fit around the edges, there is very little interference to reception from the supply.

This is also quite a reliable power supply. The vibrator had a long life and rarely required replacement. This was probably due to the design of the vibrator transformer (T1) and the buffer arrangement (C6, C7, R7 & R8). In addition, the vibrator was sealed and filled with nitrogen gas.

Summary

Commercially made HF radio transceivers were rare and expensive after WWII. However, many of these WWII transceivers came onto the surplus market at a relatively low price.

They were often extensively modified to provide crystal control of the transmitter and to provide different and extended frequency ranges. Loudspeaker output was also sometimes added. For example, amateur radio operators modified them extensively to operate on the 3.5MHz and 7.0MHz bands.

Unfortunately, the FS6 wasn't very suitable for use where mud, water, humidity and dust were common – and that included many areas where the set was expected to be used. The set had no sealing gaskets around the cabinet edges, along control shafts or over sockets to prevent the ingress of water, mud and the like. Additionally, it did not have "tropic proofing" or desiccator crystals to keep the moisture out of the set.

It also drew more current from the battery than later sets and its tuning range was quite restrictive – 4.2-6.8MHz, whereas later sets intended for the same job tuned 2-8MHz.

However, despite its many faults I believe that in the right environment, it would have proved an easy set to operate and keep in working order. As an aside, the later 122 portable transceiver cost around 1000 pounds during WWII – about the same as a Holden car soon after the war.

Military equipment wasn't cheap to produce! SC

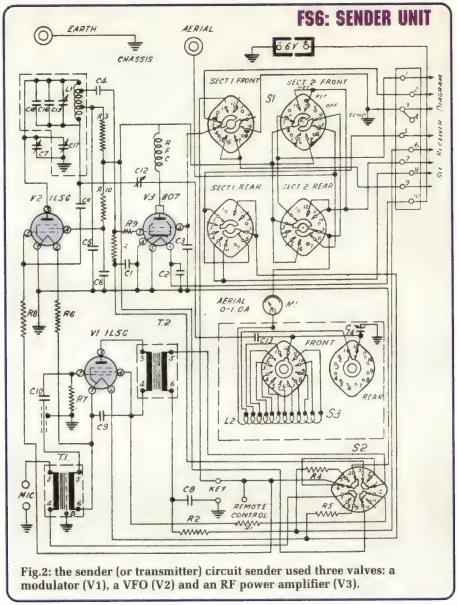


Fig.2: the sender (or transmitter) circuit sender used three valves: a modulator (V1), a VFO (V2) and an RF power amplifier (V3).

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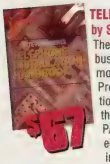

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May 1995: Build A Guitar Headphone Amplifier; FM Radio Trainer, Pt.2; Transistor/Mosfet Tester For DMMs; A 16-Channel Decoder For Radio Remote Control; Introduction to Satellite TV.

June 1995: Build A Satellite TV Receiver; Train Detector For Model Railways; 1W Audio Amplifier Trainer; Low-Cost Video Security System; Multi-Channel Radio Control Transmitter For Models, Pt.1.

July 1995: Electric Fence Controller; How To Run Two Trains On A Single Track (Incl. Lights & Sound); Setting Up A Satellite TV Ground Station; Build A Reliable Door Minder.

August 1995: Fuel Injector Monitor For Cars; Gain Controlled Microphone Preamp; Audio Lab PC-Controlled Test Instrument, Pt.1; How To Identify IDE Hard Disk Drive Parameters.

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October 1995: 3-Way Loudspeaker System; Railgower Mk.2 Walkaround Throttle For Model Railways, Pt.2; Build A Fast Charger For Nicad Batteries; Digital Speedometer & Fuel Gauge For Cars, Pt.1.

November 1995: Mixture Display For Fuel Injected Cars; CB Transverter For The 80M Amateur Band, Pt.1; PIR Movement Detector; Digital Speedometer & Fuel Gauge For Cars, Pt.2.

December 1995: Engine Immobiliser; 5-Band Equaliser; CB Transverter For The 80M Amateur Band, Pt.2; Subwoofer Controller; Knock Sensing For Cars; Index To Volume 8.

January 1996: Surround Sound Mixer & Decoder, Pt.1; Magnetic Card Reader; Build An Automatic Sprinkler Controller; IR Remote Control For The Railgower Mk.2; Battery Monitor For Nicad Batteries For Long Life.

April 1996: Cheap Battery Refills For Mobile Phones; 125W Audio Amplifier Module; Knock Indicator For Leaded Petrol Engines; Multi-Channel Radio Control Transmitter; Pt.3.

May 1996: Upgrading The CPU In Your PC; High Voltage Insulation Tester; Knightrider Bi-Directional LED Chaser; Simple Duplex Intercom Using Fibre Optic Cable; Cathode Ray Oscilloscopes, Pt.3.

June 1996: BassBox CAD Loudspeaker Software Reviewed; Stereo Simulator (uses delay chip); Rope Light Chaser; Low Ohms Tester For Your DMM; Automatic 10A Battery Charger.

July 1996: Build A VGA Digital Oscilloscope, Pt.1; Remote Control Extender For VCRs; 2A SLA Battery Charger; 3-Band Parametric Equaliser; Single Channel 6-Bit Data Logger.

August 1996: Introduction to IGBTs; Electronic Starter For Fluorescent Lamps; VGA Oscilloscope, Pt.2; Stereo Amplifier Module; Masthead Amplifier For TV & FM; Cathode Ray Oscilloscopes, Pt.4.

September 1996: VGA Oscilloscope, Pt.3; IR Stereo Headphone Link, Pt.1; High Quality PA Loudspeaker; 3-Band HF Amateur Radio Receiver; Cathode Ray Oscilloscopes, Pt.5.

October 1996: Send Video Signals Over Twisted Pair Cable; Power Control With A Light Dimmer; 600W DC-DC Converter For Car Hifi Systems, Pt.1; IR Stereo Headphone Link, Pt.2; Build A Multi-Media Sound System, Pt.1; Multi-Channel Radio Control Transmitter, Pt.8.

November 1996: 8-Channel Stereo Mixer, Pt.1; Low-Cost Fluorescent Light Inverter; Repairing Domestic Light Dimmers; Multi-Media Sound System, Pt.2; 600W DC-DC Converter For Car Hifi Systems, Pt.2.

December 1996: Active Filter Cleans Up Your CW Reception; A Fast Clock For Railway Modellers; Laser Pistol & Electronic Target; Build A Sound Level Meter; 8-Channel Stereo Mixer, Pt.2; Index To Vol.9.

January 1997: How To Network Your PC; Control Panel For Multiple Smoke Alarms, Pt.1; Build A Stereo Audio Source; Computer Controlled Stepper Motors, Pt.1; Digi-Temp Monitors Eight Temperatures.

February 1997: PC-Controlled Moving Message Display; Computer Controlled Dual Power Supply, Pt.2; Alert-A-Phone Loud Sounding Telephone Alarm; Control Panel For Multiple Smoke Alarms, Pt.2.

March 1997: Driving A Computer By Remote Control; Plastic Power FM Amplifier (175W); Signalling & Lighting For Model Railways; Build A Jumbo LED Clock; Cathode Ray Oscilloscopes, Pt.7.

April 1997: Simple Timer With No ICs; Digital Voltmeter For Cars; Loudspeaker Protector For Stereo Amplifiers; Model Train Controller; A Look At Digital Analog, Pt.1; Cathode Ray Oscilloscopes, Pt.8.

May 1997: Neon Tube Modulator For Light Systems; Traffic Lights For A Model Intersection; The Spacewriter – It Writes Messages In Thin Air; A Look At Signal Tracing; Pt.2; Cathode Ray Oscilloscopes, Pt.9.

June 1997: PC-Controlled Thermometer/Thermostat, TV Pattern Generator, Pt.1; Audio/RF Millivoltmeter, Pt.1; Current Spike Controller for 12V/24V Motors; Manual Control Circuit For Stepper Motors.

July 1997: Infrared Remote Volume Control: A Flexible Interface Card For PCs; Points Controller For Model Railways; Colour TV Pattern Generator, Pt.2; An In-Line Mixer For Radio Control Receivers.

August 1997: The Bass Barrel Subwoofer; 500 Watt Audio Power Amplifier Module; A TENs Unit For Pain Relief; Addressable PC Card For Stepper Motor Control; Remote Controlled Gates For Your Home.

September 1997: Multi-Spark Capacitor Discharge Ignition; 500W Audio Power Amplifier, Pt.2; A Video Security System For Your Home; PC Card For Controlling Two Stepper Motors; HiFi On A Budget.

October 1997: Build A 5-Digit Tachometer; Add Central Locking To Your Car; PC-Controlled 6-Channel Voltmeter; 500W Audio Power Amplifier, Pt.3; Customising The Windows 95 Start Menu.

November 1997: Heavy Duty 10A 240VAC Motor Speed Controller; Easy-To-Use Cable & Wiring Tester; Build A Musical Doorbell; Replacing Foam Speaker Surrounds; Understanding Electric Lighting Pt.1.

December 1997: Speed Alarm For Cars; 2-Axis Robot With Gripper; Stepper Motor Driver With Onboard Buffer; Power Supply For Stepper Motor Cards; Understanding Electric Lighting Pt.2; Index To Vol.10.

January 1998: Build Your Own 4-Channel Lightshow, Pt.1 (runs off 12VDC or 12VAC); Command Control System For Model Railways, Pt.1; Pan Controller For CCD Cameras.

February 1998: Multi-Purpose Fast Battery Charger, Pt.1; Telephone Exchange Simulator For Testing; Command Control System For Model Railways, Pt.2; Build Your Own 4-Channel Lightshow, Pt.2.

April 1998: Automatic Garage Door Opener, Pt.1; 40V 8A Adjustable Power Supply, Pt.1; PC-Controlled 0-30kHz Sinewave Generator; Build A Laser Light Show; Understanding Electric Lighting; Pt.5.

May 1998: Troubleshooting Your PC, Pt.1; Build A 3-LED Logic Probe; Automatic Garage Door Opener, Pt.2; Command Control For Model Railways, Pt.4; 40V 8A Adjustable Power Supply, Pt.2.

June 1998: Troubleshooting Your PC, Pt.2; Universal High Energy Ignition System; The Reading Rule Tester; Infrared Universal Stepper Motor Controller; Command Control For Model Railways, Pt.5.

July 1998: Troubleshooting Your PC, Pt.3; 15-W/Ch Class-A Audio Amplifier, Pt.1; Simple Charger For 6V & 12V SLA Batteries; Automatic Semiconductor Analyser; Understanding Electric Lighting, Pt.8.

August 1998: Troubleshooting Your PC, Pt.4 (Adding Extra Memory); Simple I/O Card With Software; Stepper Motor Build A Beat Triggered Strobe; 15-W/Ch Class-A Stereo Amplifier, Pt.2.

September 1998: Troubleshooting Your PC, Pt.5; A Blocked Air-Filter Alarm; Wax-Wax Pedal For Guitars; Jacob's Ladder; Car Engine Indicator For Cars; Capacity Indicator For Rechargeable Batteries.

October 1998: Lab Quality AC Millivoltmeter, Pt.1; PC-Controlled Stress-O-Meter; Versatile Electronic Guitar Limiter; 12V Trickle Charger For Float Conditions; Adding An External Battery Pack To Your Flashgun.

November 1998: The Christmas Star; A Turbo Timer For Cars; Build A Poker Machine, Pt.1; FM Transmitter For Musicians; Lab Quality AC Millivoltmeter, Pt.2; Setting Up A LAN Using TCP/IP; Understanding Electric Lighting, Pt.9; Interfacing Multi-Media Peripherals.

December 1998: Engine Immobiliser Mk.2; Thermocouple Adaptor For DMMs; Regulated 12V DC Plugpack; Build A Poker Machine, Pt.2; Improving AM Radio Reception, Pt.2; Mixer Module For F3B Gliders.

January 1999: High-Voltage Megohm Tester; Getting Started With BASIC Stamp; LED Bargraph Modules For Cars; Keypad Engine Immobiliser; Improving AM Radio Reception, Pt.3.

March 1999: Getting Started With Linux; Pt.1; Build A Digital Anemometer; 3-Channel Current Monitor With Data Logging, Simple DIY PIC Programmer; Easy-To-Build Stereo Preamplifier; Low Distortion Audio Signal Generator, Pt.2; Electric Lighting, Pt.12.

April 1999: Getting Started With Linux; Pt.2; High-Power Electric Fence Controller; Bass Cube Subwoofer; Programmable Thermostat/Thermometer; Build An Infrared Remote Control For Cars.

May 1999: The Line Dancer Robot; An X-Y Table With Stepper Motor Control, Pt.1; Three Electric Fence Testers; Heart Of LEDs; Build A Carbon Monoxide Alarm; Getting Started With Linux; Pt.3.

June 1999: FM Radio Tuner Card For PCs; X-Y Table With Stepper Motor Control, Pt.2; Programmable Ignition Timing Module For Cars, Pt.1; Hard Disk Drive Upgrades Without Reinstalling Software?

July 1999: Build A Dog Silencer; 10µH to 19.99mH Inductance Meter; Build An Audio-Video Transmitter; Programmable Ignition Timing Module For Cars, Pt.2; X'Z' Table With Stepper Motor Control, Pt.3.

August 1999: Remote Modem Controller; Daytime Running Lights For Cars; Build A PC Monitor Checker; Switching Temperature Controller; X'Z' Table With Stepper Motor Control, Pt.4; Electric Lighting, Pt.14.

September 1999: Autonomouse The Robot, Pt.1; Voice Direct Speech Recognition Module; Digital Electronic Capacitance Meter; X'Z' Table With Stepper Motor Control, Pt.5; Peltier-Powered Can Cooler.

October 1999: Build The Railpower Model Train Controller, Pt.1; Semiconductor Curve Tracer; Autonomouse The Robot, Pt.2; X'Z' Table With Stepper Motor Control, Pt.6; Remote Home Theatre.

November 1999: Electric Lighting, Pt.15; Setting Up An E-mail Server; Quad Servo Driver For Cars, Pt.1; Multi-Colour LED Christmas Tree; Build An Intercom Station Expander; Foldback Loudspeaker System For Musicians; Railpower Model Train Controller, Pt.2.

December 1999: Electric Lighting, Pt.16; Build A Solar Panel Regulator; The PC Powerhouse (gives fixed +12V, +9V, +6V & +5V rails); The Fortune Finder Metal Locator; Speed Alarm For Cars, Pt.2; Railpower Model Train Controller, Pt.3; Index To Volume 12.

January 2000: Spring Reverberation Module; An Audio-Video Test Generator; Build The Picman Programmable Robot; A Parallel Port Interface Card; Off-Hook Indicator For Telephone Lines.

February 2000: Multi-Sector Sprinkler Controller; A Digital Voltmeter For Your Car; An Ultrasonic Parking Radar; Build A Safety Switch Checker; Build A Sine/Square Wave Oscillator.

March 2000: Resurrecting An Old Computer; Low Distortion 100W Amplifier Module, Pt.1; Electronic Wind Vane With 16-LED Display; Glowplug Driver For Powered Models; The Octivio Car Computer, Pt.1.

May 2000: Ultra-LD Stereo Amplifier, Pt.2; Build A LED Dice (With PIC Microcontroller); Low-Cost AT Keyboard Translator (Converts IBM Scan-Codes To ASCII); 50A Motor Speed Controller For Models.

June 2000: Automatic Rain Gauge With Digital Readout; Parallel Port VHF FM Receiver; L/I Powerhouse Switchmode Power Supply (1.25V to 40V) Pt.1; CD Compressor For Cars Or The Home.

July 2000: A Moving Message Display; Compact Fluorescent Lamp Driver; El-Cheapo Musicians' Lead Tester; L/I Powerhouse Switchmode Power Supply (1.2V to 40V) Pt.2.

August 2000: Build A Theremin For Really Eerie Sounds; Come In Spinner (writes messages in "thin-air"); Proximity Switch For 240VAC Lamps; Structured Cabling For Computer Networks.

September 2000: Build A Swimming Pool Alarm; An 8-Channel PC Relay Board; Fuel Mixture Display For Cars, Pt.1; Protoboards – The Easy Way Into Electronics, Pt.1; Cybug The Solar Fly.

October 2000: Guitar Jammer For Practice & Jam Sessions; Booze Buster Breath Tester; A Wand-Mounted Inspection Camera; Installing A Free-Air Subwoofer In Your Car; Fuel Mixture Display For Cars, Pt.2; Protoboards – The Easy Way Into Electronics, Pt.2.

November 2000: Santa & Rudolf Christie Display; 2-Channel Guitar Preamplifier, Pt.1; Message Bank & Missed Call Alert; Electronic Thermostat; Protoboards – The Easy Way Into Electronics, Pt.3.

December 2000: Home Networking For Shared Internet Access; Build A Bright-White LED Torch; 2-Channel Guitar Preamplifier, Pt.2 (Digital Reverb); Driving An LCD From A Parallel Port; Build A Nixie Clock; Protoboards – The Easy Way Into Electronics, Pt.4; Index To Vol.13.

January 2001: How To Transfer LPs & Tapes To CD; The LP Doctor – Clean Up Clicks & Pops, Pt.1; Arbitrary Waveform Generator, 2-Channel Guitar Preamplifier, Pt.3; PIC Programmer & Installer.

February 2001: How To Observe Meteors Using Junked Gear; An Easy Way To Make PC Boards; L/I Pulser Train Controller; Mid-Mate – A MIDI Interface For PCs; Build The Bass Blazer; 2-Metre Elevated Groundplane Antenna; The LP Doctor – Clean Up Clicks & Pops, Pt.2.

March 2001: Making Photo Resist PC Boards; Big-Digit 12/24 Hour Clock; Parallel Port PIC Programmer & Checkerboard; Protoboards – The Easy Way Into Electronics, Pt.5; A Simple MIDI Expansion Box.

April 2001: A GPS Module For Your PC; Dr Video – An Easy-To-Build Video Stabiliser; A Tremolo Unit For Musicians; Micromitter 49MHz Stereo Transmitter; Intelligent Nicad Battery Charger; Computer Tips – Tweaking Internet Connection Sharing.

May 2001: Powerful 12V Mini Stereo Amplifier; Microcontroller-Based 4-Digit Counter Module; Ultra-Bright LED Torches Type Two; Mid-Mate – A Multi-Voltage Power Supply; Using Linux To Share An Internet Connection, Pt.1; Computer Tips – Tweaking Windows With TweakUI.

June 2001: Fast Universal Battery Charger, Pt.1; Phonome – Call, Listen In & Switch Devices On & Off; L'il Snooper – A Low-Cost Automatic Camera Switcher; Using Linux To Share An Internet Connection, Pt.2; A PC To Die For, Pt.1 (Building Your Own PC).

July 2001: The HeartMate Heart Rate Monitor; Do Not Disturb Telephone Timer; Pre-Loaded Microwave Clock; Fast Universal Battery Charger, Pt.2; A PC To Die For, Pt.2; Backing Up Your Email.

August 2001: Direct Injection Box For Musicians; Build A 200W Mosfet Amplifier Module; Headlight Reminder For Cars; Mini-Bits 3-Digit Frequency Counter Module; A PC To Die For, Pt.3; Using Linux To Share An Internet Connection, Pt.3.

September 2001: Making MP3s – Rippers & Encoders; Build Your Own MP3 Jukebox, Pt.1; PC-Controlled Mains Power; Personal Stereo Source For Tinnitus Sufferers; The Sooper Sooper Directional Microphone; Using Linux To Share An Internet Connection, Pt.3.

October 2001: A Video Microscope From Scrounged Parts; Build Your Own MP3 Jukebox, Pt.2; Sooper Sensitive Metal Detector; An Automotive Thermometer; Programming Adapter For Atmel Microcomputers; Building Your Own PC – One Man's Approach.

November 2001: Ultra-LD 100W RMS/Channel Stereo Amplifier, Pt.1; Neon Tube Modulator; Build An Over-Sized Audio/Video Distribution Amplifier; Short Message Recorder Player; Computer Tips.

December 2001: A Look At Windows XP; Build A PC Infrared Transceiver; Ultra-LD 100W RMS/Ch Stereo Amplifier, Pt.2; Pardy Lights – An Intriguing Colour Display; PIC Fun – Learning About Micros.

January 2002: Touch And/Or Remote-Controlled Light Dimmer, Pt.1; A Cheap 'n'Easy Motorbike Alarm; 100W RMS/Channel Stereo Amplifier, Pt.3; Build A Raucous Alarm; Tracking Down Computer Software Problems; Electronic Power Steering FAQs On The MP3 Jukebox.

February 2002: 10-Channel IR Remote Control Receiver; 2.4GHz High-Power Audio-Video Link; Assemble Your Own 2-Way Tower Speakers; Touch And/Or Remote-Controlled Light Dimmer, Pt.2; Booting A PC Without A Keyboard; 4-Way Event Timer.

March 2002: Mighty Midget Audio Amplifier Module; The Itsy-Bitsy USB Lamp; 6-Channel IR Remote Volume Control, Pt.1; RIAA Preamplifier For Magnetic Cartridges; 12/24V Intelligent Dual Power Battery Charger; Generate Audio Tones Using Your PC's Soundcard.

April 2002: How To Get Into Avionics; Automatic Single-Channel Light Dimmer, Pt.1; Build A Water Level Indicator; Multiple-Output Bench Power Supply; Versatile Multi-Mode Timer; 6-Channel IR Remote Volume Control, Pt.2; More FAQ's On The MPs Jukebox Player.

PLEASE NOTE: November 1987 to March 1989, June 1989, August 1989, December 1989, May 1990, February 1991, June 1991, August 1991, January 1992, February 1992, July 1992, August 1992, September 1992, November 1992, December 1992, January 1993, May 1993, February 1996, March 1998 and February 1999 are now sold out. All other issues are presently in stock. For readers wanting articles from sold-out issues, we can supply photostat copies (or fax sheets) at $7.70 per article (includes p&p). When supplying photostat articles or back copies, we automatically supply any relevant notes & errata at no extra charge. A complete index to all articles published to date is available on floppy disk for $11 including p&p, or can be downloaded free from our web site: www.siliconchip.com.au.

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Substituting a 3-spring reverb unit

Could you please advise if I could use a "Belton" 3-spring reverb unit in your module described in the January 2000 issue? If so, where would I be able to buy the PC board (014002000) from? (H. P., via email).

● Whether or not you can use your 3-spring unit largely depends on its input and output impedances. As presented, our circuit drives an 8Ω input coil and the output impedance is 800Ω. If your unit broadly matches these figures or has higher impedances, then you can probably make the circuit work.

You can purchase the PC board from RCS Radio: www.cia.com.au/rcsradio

LEDs flashing on mixture meter

I have constructed the Fuel Mixture Display kit described in the "EFI Tech Special". The kit is not functioning as it should, with lights buzzing left and right on idle at normal temperature. The red light stays on all the time. If I adjust the trimpot, the yellow light shows. What could be the fault in this situation? (E. B., via email).

● There isn't too much that can go wrong with this circuit. It seems that the IC is driving the LEDs from one extreme to the other as the yellow (rich) and red (lean) ones light with variation of VR1.

Check that there are no shorts between tracks on the PC board, by scraping between tracks with a sharp knife. Also check that there are no solder bridges between pins on IC1 by comparing the published pattern with the underside of your board.

It is possible that the input at pin 5 has been damaged. It can be protected by connecting a .01μF capacitor between pin 5 and pin 4 and using a 100kΩ resistor in series with the input from the oxygen sensor.

Altec Lansing re-cone kits available

All those owners of Altec Lansing professional drivers (515s, 421/921, 418/918, 411, etc) who may have been told that genuine re-cone kits were no longer available, now that the Altec Lansing name has been sold to that computer speaker company, might be interested to know that there is a source of GENUINE parts in the USA at what are reasonable prices.

I've recently imported 22 cone and coil sets for various types of Altec Lansing drivers and they are as genuine as you could get; they even smell like the originals! The coils are wound on the original machinery that Altec used by a guy who used to work for them, while the cones are sourced from outside, to the original specifications. (Brad Sheagold, Collaroy, NSW. bwscdm@tech2U.com.au)

Transistor-assisted ignition query

I have a 1973 Mercedes 280S with carburettor and standard points/coil ignition. Did you ever publish an article on building a transistor-assisted ignition system, where the transistor carried the coil primary current and the points fed only a small current for the base circuit?

I have already emailed your office for the two High Energy Ignition System articles described in 1998 and 1999 but the simple system mentioned above is suggested in the Bosch automotive book. (D. J., via email).

● The High Energy Ignition System is a transistor-assisted system. A high voltage transistor does the switching while a current of about 250mA is switched by the points. The points current cannot be too small otherwise they tend to oil up and stop working.

18V setting for Nicad discharger

Looking at your Automatic Discharger for nicad battery packs in the September 1994 issue, is it possible to include an 18V range? I have an 18V cordless drill battery pack. What would I need to change or add? (H. P., via email).

● Yes, you can use the Nicad Discharger to discharge an 18V battery pack. This pack comprises 15 cells and the 1.1V per cell voltage would be 16.5V.

To add the necessary 18V switch position, you need to replace the 1.8kΩ resistor at the bottom of the voltage divider with a 600Ω (560Ω plus 39Ω) resistor and a 1.2kΩ resistor, with the 1.2kΩ value going to ground. The junction of the 1.2kΩ resistor and 600Ω resistor would be the new 18V battery position.

Note that the LM358 is rated for a supply voltage of 32V and so it can be used here without change. Other components should also cope. The exception is the 27Ω 5W resistor which will glow red hot under reverse polarity connection with 18V applied. It would be best to replace this with a parallel combination of two 56Ω 5W resistors, one on top of the PC board and the other in parallel, on the underside of the board.

Hum on FM transmitter

I recently bought the MiniMitter FM transmitter from Jaycar and after assembling and tuning it in, I'm getting a hum on the radio. I don't notice it too much with music playing but I am using it as a baby monitor sometimes and was hoping for better results. I've tried it on two different radios and find the same problem. I've also tried moving the antennas around but that doesn't help either. Do you suppose I'm transmitting too close (7-8m)? (J. R., Brisbane, Qld).

● There should not be any evidence of hum when used with a signal source such as a CD player. The hum could

Tachometer for a Go-Kart

I've recently purchased your tacho kit from Jaycar (Cat KC-5290) and would like some advice on modifying it for use on a Go-Kart.

First, as a kart has no power supply, I would like to use a 9V battery and on/off switch rather than a 12V auto supply. Next is the connection to the kart's ignition system, which has three wires to the motor and a fourth brown wire for a cut-out switch. They are as follows: Red – high voltage exciter input; Black – earth; Yellow – trigger.

Could you please advise the correct connection from these to the tacho unit and the necessary component modifications to adapt it to a 9V battery. (S. B., via email).

- You can operate the tachometer on 9V without changes to the circuit. Your Go-Kart appears to have a magneto ignition and would probably not drive the tachometer directly without some changes.

You could try connecting the red wire from the magneto to the "ignition coil -ve" input on the tachometer. If this doesn't work try the yellow trigger wire at the "low input" on the tachometer instead.

Note that the 2.2µF capacitor at the anode of D1 may need to be removed from circuit for successful operation.

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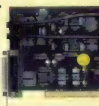
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be caused by expecting the transmitter to operate from very low signal level or from a high impedance. You do not say how the baby monitor circuitry is connected or how the microphone is amplified, but using a microphone could be the problem.

Hum can also be evident if the FM tuner or radio is set to receive a subharmonic rather than the main fundamental frequency. Try tuning the receiver to another frequency for best signal. Also you may be getting interference from another off-air station which could cause the hum problem. In this case, retune both transmitter and receiver to a quieter part of the FM band.

Control circuit for thermatic fans

I have a Falcon EBII XR6. These models came with a belt-driven fan. I purchased the twin thermatic fans with shroud from an EF Falcon as the radiator is the same. I need to set up a switch somehow. I'm not wanting to use the Davies-Craig unit as I'm trying to get a factory look. I thought I could get something to work off the output of the temperature gauge in the dash but I can't find something that will work. Any help would be gratefully appreciated. (R. W., via email).

- Have a look at our article entitled "Thermostatic Switch For Car Radiator Fans" in the March 1992 issue. We can supply the issue for $7.70 including postage.

Fuel mixture display for a hotrod

I've built the Fuel Mixture Display kit (September & October 2000) which I brought from Dick Smith Electronics in New Zealand. The kit is going to be used on my hotrod. However, I'm having problems locating the Bosch EGO probe you listed in the kit as being matched to the unit. The local Bosch agent said the part number is incorrect (LSM11 , 0258104002). Is the number correct or was there a mistake?

Even if you can tell me what type of car the above probe is from it would be helpful. (J. B., Stratford, NZ).

- The Bosch type number is correct. It is a sensor generally used for sensing exhaust smoke stacks, not neces-

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Electric fence controller

I have purchased the High Power Electric Fence Controller described in the April 1999 issue of SILICON CHIP. I put the kit together and ran it through both the tests.

I got 340V on the first test and everything ran perfectly for about a minute on the second test, then everything went dead. I had a good spark in the test. I can now only get a maximum of 12-13V across D2 and earth on the voltmeter when adjusting VR1.

I have replaced both ICs and the zener diode, but to no avail. What other component is likely to have failed? Is it likely to be in the DC-DC converter or the error amplifier? (C. R., via email).

● Take out Triac1 and then check if you can get the correct voltage at diode D2. If so, the Triac has failed. If the voltage is still low, remove the 7µF 250V capacitor connection and again check for voltage.

Having the correct voltage with the capacitor out is a sign that transformer T2 has a short and will need rewinding.

If the voltage is still not correct, perhaps Q1 is shorted. Test this with a multimeter between Drain and Source.

sarily in the automotive industry.

The sensor can be purchased from Farnell (NZ 649 357 0646) but it is cheaper to get an EGO sensor (eg, as used in Ford and Holden 6-cylinder cars) from a wrecker's yard. The Fuel Mixture Display operates successfully with most automotive sensors.

Balance control for the Ultra-LD amplifier

I note with interest that you have not provided for a balance control in the design of the Ultra-LD Amplifier described in the November 2001 to January 2002 issues. This a disappointing omission for me as I suffer from a slight hearing loss in one ear and the balance control, to some degree, compensates for this.

I wonder what would have been behind the decision not to include the control? (L. S., via email).

● Most audiophile stereo amplifiers eliminate the balance control and the tone controls because they do degrade the performance. Balance controls also tend to be hard to obtain.

If you wanted to put in a balance control you could do so using the same scheme as we employed in the 50W stereo amplifier published in the March & April 1995 issues. This used a single pole 12-position rotary switch and resistors. We can supply these back issues for $7.70 each including postage.

Using the Sparkrite Hall Effect pickup

I just purchased a high energy ignition kit (June 1998) from Dick Smith Electronics. I am using this kit with a Sparkrite Hall Effect pickup which I purchased secondhand. This Hall Effect pickup is over 10 years old and I know it was used with one of the first versions of the High Energy Ignition over 10 years ago. I would just like to ask if you know how to connect this Hall Effect sensor to the current High Energy Ignition?

The Hall Effect pickup only has two connections, which is a problem as the High Energy Ignition requires three connections to the Hall Effect sensor. I also didn't get the instructions with the Hall Effect sensor so I don't know what's going on. Also I found out that the Sparkrite sensor can't be used with V8s. This is a problem as I bought it to put on my Holden V8. Would it be possible to modify the sensor to fit a Bosch V8 distributor?

I can make up my own mounting plates/brackets and was thinking about setting it up like the Siemens HKZ101 Hall Effect sensor, with a stationary magnet and using a Bosch Vane. Will this work? I would get a Siemens sensor but they are no longer available. Would you know of any other Hall Effect sensors suitable for my application which are currently available? (S. N., via email).

● The Sparkrite Hall sensor is only a one-wire unit with the case connection for earth. The wire output is actually connected directly to the supply for the Hall Effect sensor, with a 330Ω resistor between the supply and output. Connection to the 12V supply requires a resistor in series so that the output terminal will pull the Hall supply lower than normal. The output voltage does not swing fully from 12V to ground and is not suitable for the High Energy Ignition circuit.

You could experiment with the resistors at transistor Q2 so that the Sparkrite sensor will operate the circuit. Using a 330Ω pullup resistor from the Hall Effect sensor terminal to the 12V supply will give an output swing from about 5V down to 3V with magnets passing the sensor. Use a 1kΩ resistor at Q2's base to emitter. This value may need to be determined experimentally using a trimpot.

As you state, the Sparkrite sensor is not suitable for 8-cylinder engines as

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Questions on guitar preamp

I have a few questions regarding the guitar preamp featured in the November 2000 issue of SILICON CHIP, sold in kit form by Jaycar Electronics, Cat KC-5303. Can you please tell me:

(1) To connect the second channel's PC board to the main board, do I need to connect the points marked 'TP1'? If not, what are they for?

(2) All of the connection points on the back (FX send/rtn, balanced out & unbalanced out) have a ground point, except for the 'line input' point. Should this line be grounded somewhere?

(3) On the schematic for the power supply, where the leads are earthed to the chassis, a 0.47µF capacitor is shown going from the chassis earth point to a regular earth point. Where should this capacitor go to earth? (P. M., via email).

● Do not interconnect the TP1 points on the first and second channels. These are test points to adjust the offset in each amplifier (IC2) using trimpot VR7. The line input shares the unbalanced output ground point.

The 0.47µF capacitor connects from signal ground to chassis as shown in Fig.1 of the January 2001 issue of SILICON CHIP.

they did not make a rotating magnet assembly for these distributors.

The HKZ101 Hall sensor is still available from Jaycar (Cat ZD-1900) but the Bosch rotating vane is not available. This would need to be manufactured using a steel cup-shaped vane with eight slots spaced 45° apart.

This vane can be glued to the existing rotor button using high temperature (120°C or more) epoxy or similar.

Matching amplifiers to speakers

I am concerned about possible damage to an amplifier when more 'powerful' speakers are connected. For example, if 150W speakers are connected to a 100W amplifier, is there the possibility of the amplifier being damaged?

Thinking along the lines of source/load matching as in antennas it seems to me that, provided the amp/speaker matching is correct, there should be no problem. (N. D., Carine, WA)

● There is no chance of damage by connecting 150W speakers to a 100W amplifier. Speakers are passive transducers. Provided their impedance is within normal limits, no damage will result.

Speed controller for R/C cars

I would like to suggest a project for an electronic speed controller for radio controlled cars. There are commercial models available but they are in the "cost you an arm and a leg" price range and I am sure such a design would be greatly appreciated by all of us dads who spend half of our lives repairing our son's R/C cars. R. H., Yatala Vale, SA).

● We described a 50A speed control for R/C cars in the May 2000 issue. We can supply this issue for $7.70 including postage.

Converting a UPS to use as inverter

I have a Chloride 12V computer UPS I want to utilise as an inverter but it needs 240V to be on at the moment of a blackout before the 12V inverter will work. This is of no value to me in the fieldwhen trying to operate a drill or grinder. How can I fix it? (R. M., via email).

● Without knowing anything about the circuit, we cannot suggest a modification. However, it probably has a stepdown transformer and rectifier to produce a DC voltage from the mains. When that disappears, the inverter kicks in. You need to measure that voltage and then alter the monitoring circuit to disable it.

Notes & Errata

Mighty Midget 50W Module, March 2002: the list of parts for the capacitors should be as follows: 2 4700µF 16VW, 1 2200µF 16VW, 2 0.22µF MKT, 4 0.1µF MKT. **SC**

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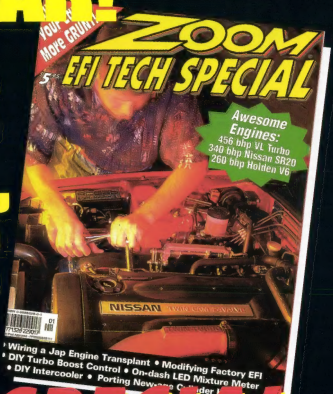

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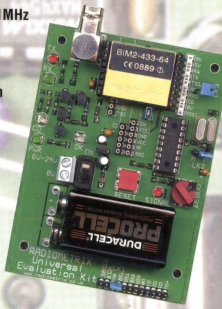

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